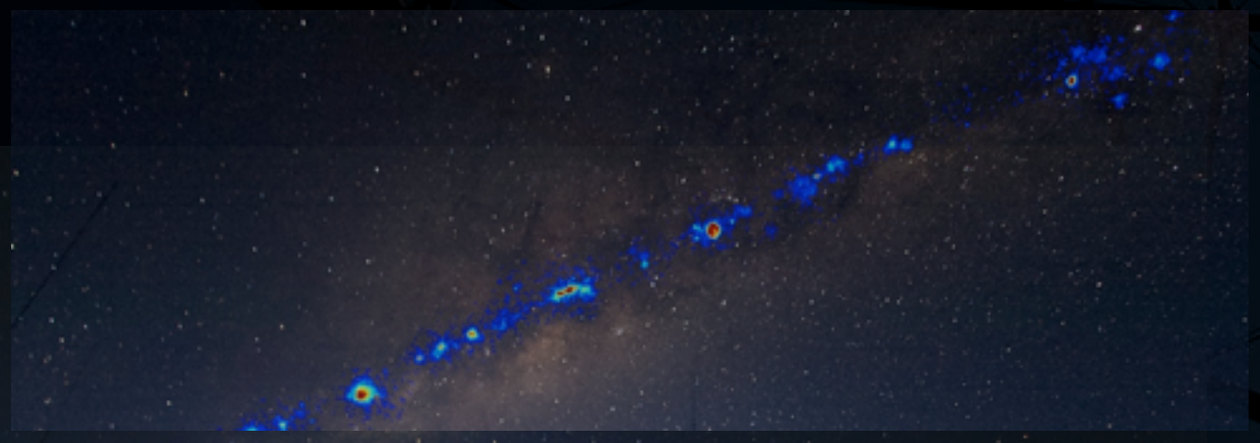
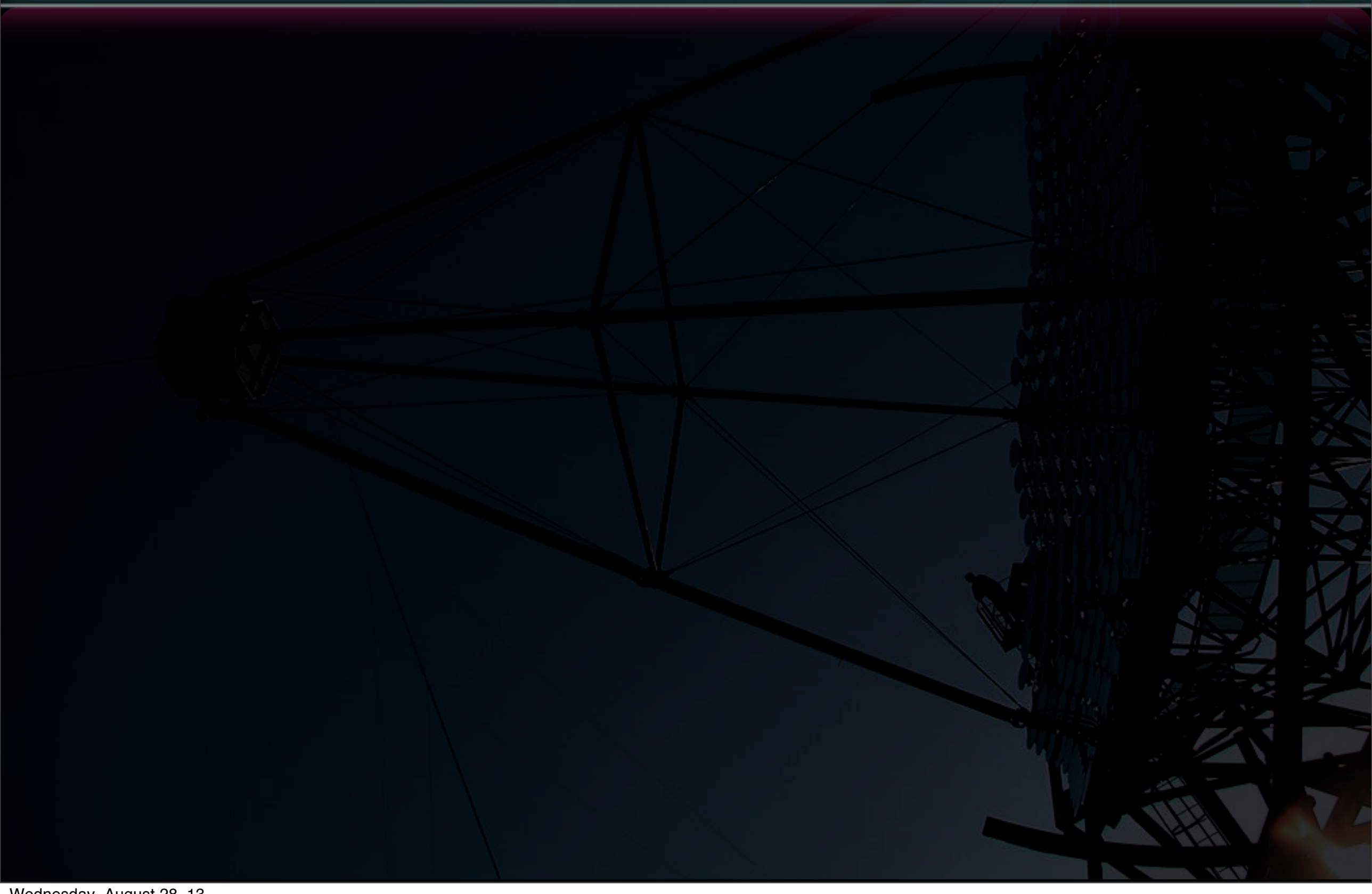
Recent results on Galactic TeV gamma-ray sources

Emma de Oña Wilhelmi
IEEC-CSIC, Barcelona



Outlook



Outlook

- Current TeV gamma-ray telescopes
  Non-thermal radiation from 0.1 to tens of TeV
  Covering the North and the South hemispheres

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  - Non-thermal radiation from 0.1 to tens of TeV
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Outlook

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  - Late stages of massive stars
  - SNRs, PWNe, Binary Systems
  - Galactic Center, Unidentified Sources

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  - Galactic Center, Unidentified Sources
  - New types?

Production of TeV gamma-ray emission

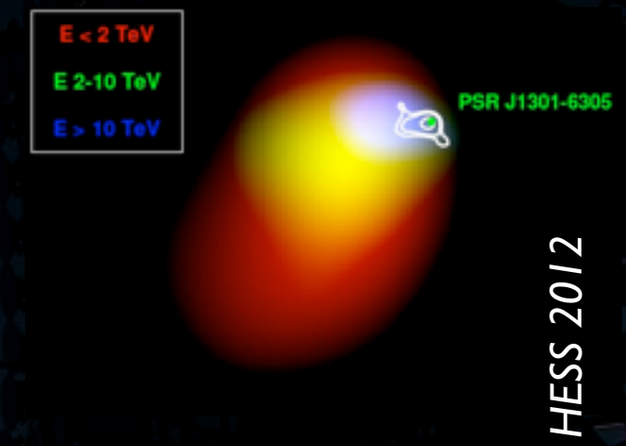
- Particles have to be accelerated to Ee,p>1 TeV
- If electrons:

$$\gamma_{LE} + e^{\pm}_{HE} \rightarrow \gamma_{HE} + e^{\pm}_{LowerE}$$

IC on Starlight, CMB and/or dust

$$e^{\pm}_{LE} + B \rightarrow \gamma_{LE} + e^{\pm}_{LowerE}$$

Synchrotron emission in presence of B



HESS 2012

TeV gamma-rays can trace the electron population (independently of the B distribution)

$N_e \propto E^{-\delta} \Rightarrow N_\gamma \propto E^{-(\delta+1)/2}$

$Ee=(18\,TeV)\ E_{TeV}^{1/2}$

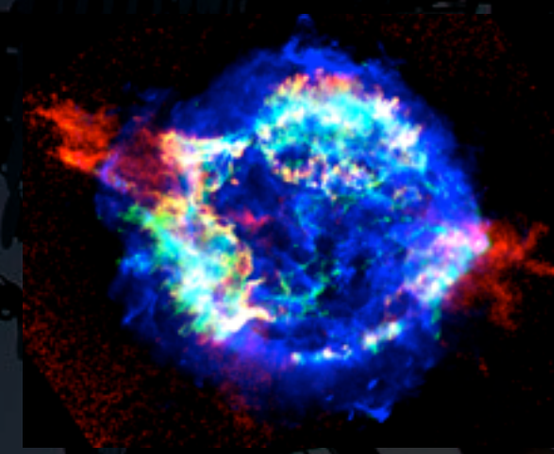
- If hadrons:

$$p + p \rightarrow \pi^o + X + \ldots + \pi^{\pm}$$
$$\hookrightarrow \gamma + \gamma \qquad \hookrightarrow \nu_\mu + \nu_e + \ldots$$

Trace Cosmic Rays accelerator/s Ep ~10 E_{TeV}

$N_p \propto E^{-\delta} \Rightarrow N_\gamma \propto E^{-\delta}$

Search for PeVatrons


Cas A - J.Vink 2004

The Development of the Cherenkov Telescopes Field

HESS
2002 – 2012

MAGIC
2003 – 2011

MAGIC II
2009 – 2015

HESS 2
2012 – 2015

HEGRA
1987 – 2002

CANGAROO
1992 – 2011

CAT
1996 – 2002

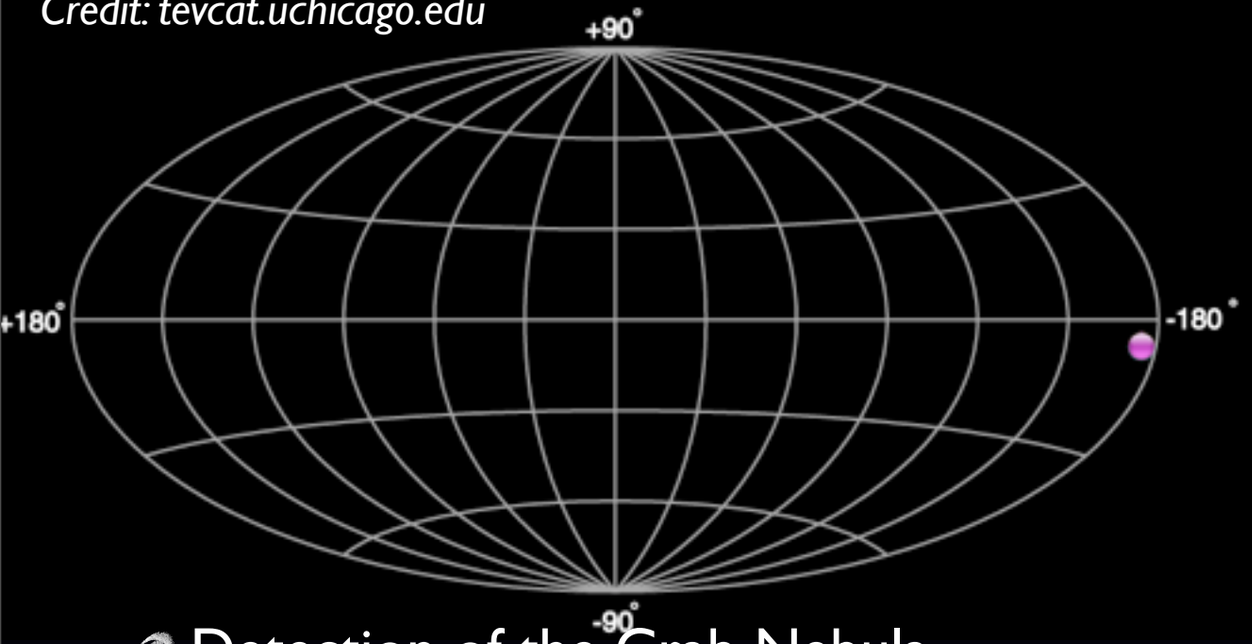
VERITAS
2006 – 2013

CTA
2015

Whipple
1980

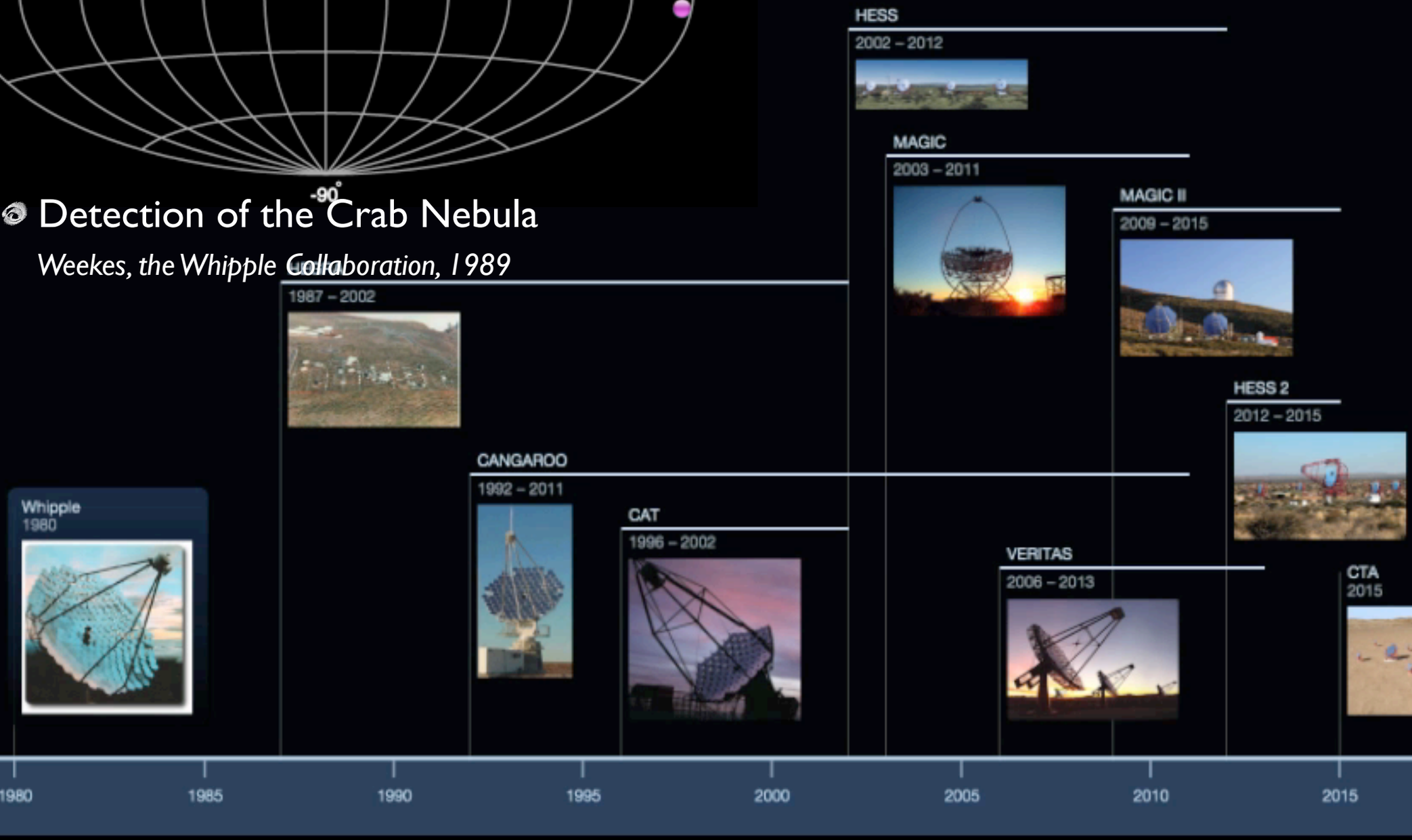
1980 1985 1990 1995 2000 2005 2010 2015 2020 Year

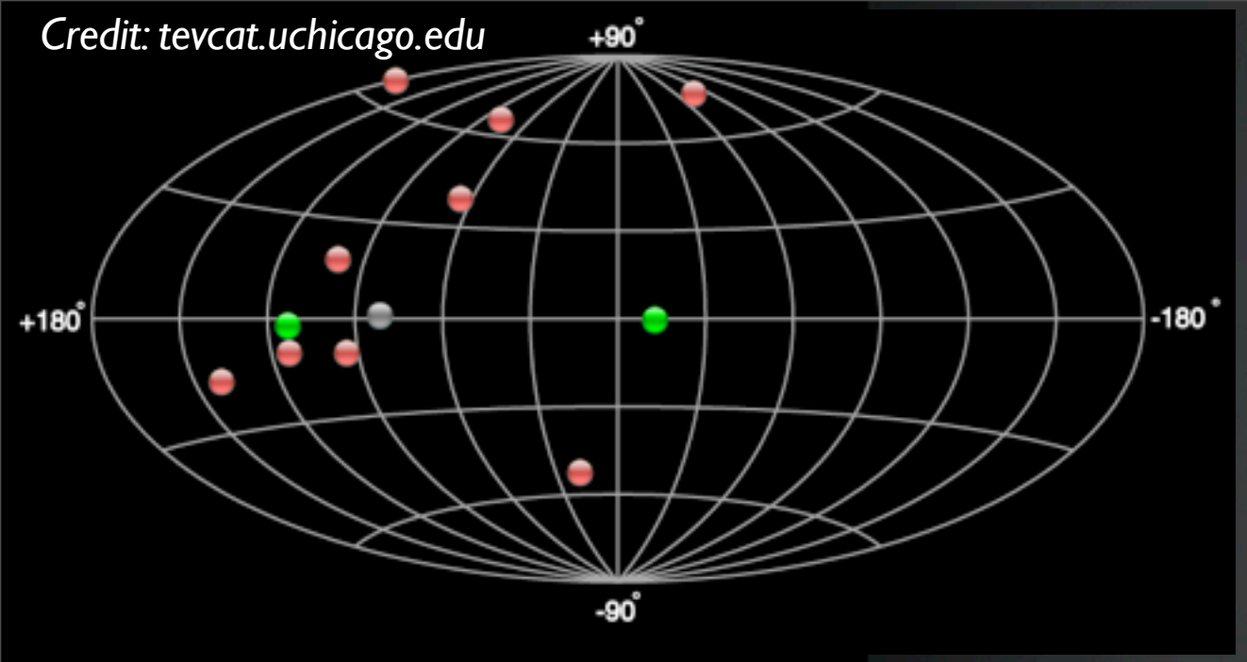
Credit: tevcat.uchicago.edu

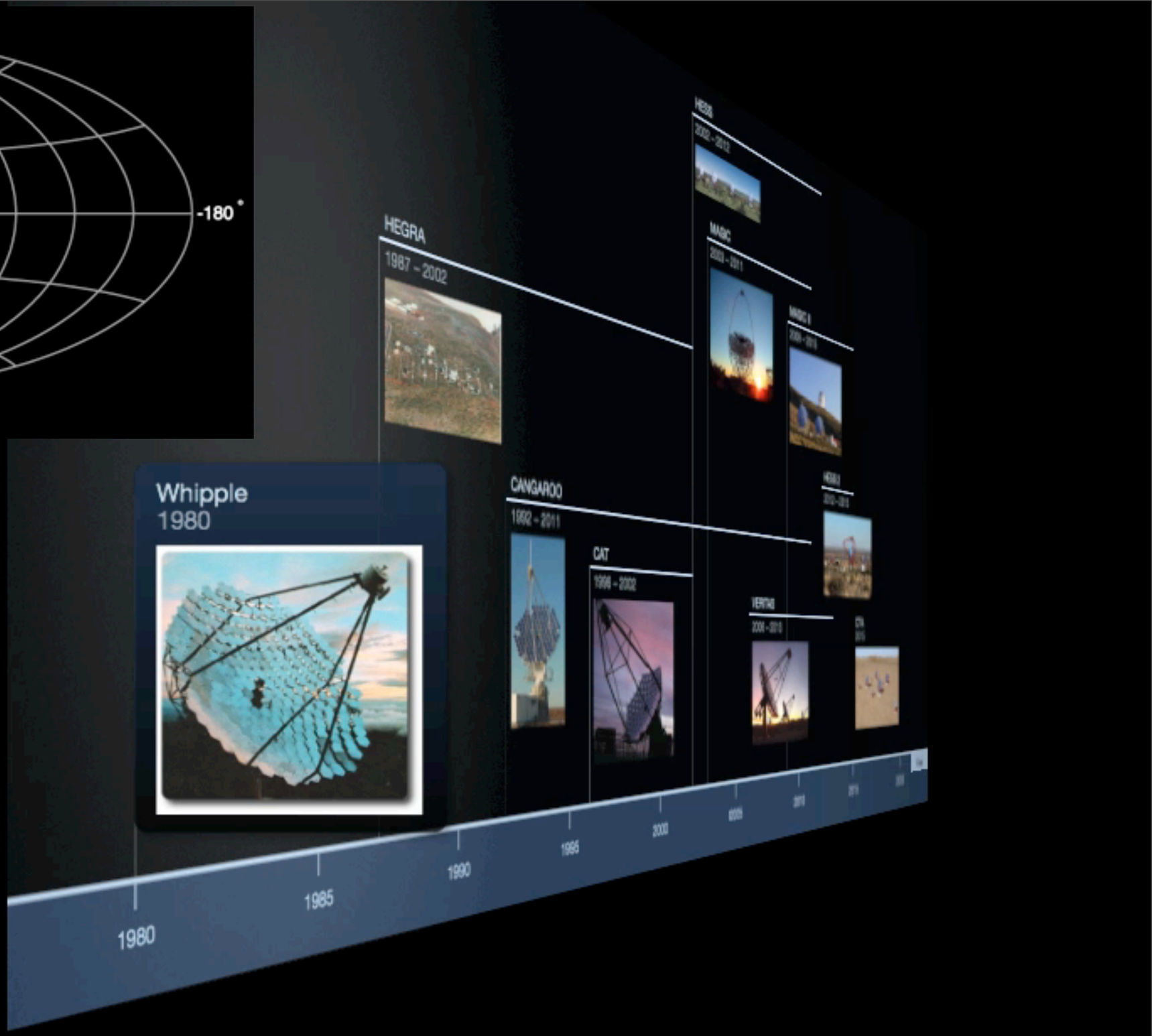


- Detection of the Crab Nebula

  Weekes, the Whipple Collaboration, 1989




Credit: tevcat.uchicago.edu
+90°
+180°
-180°
-90°


Whipple
1980
HEGRA
1987 – 2002
CANGAROO
1992 – 2011
CAT
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MAGIC
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MAGIC II
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VERITAS
2006 – 2012
1980
1985
1990
1995
2000

HEGRA
1987 – 2002

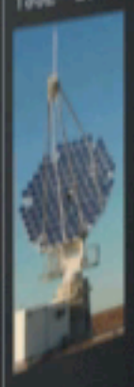
HESS
2002 - 2012

MAGIC
2003 - 2011

MAGIC II
2009 - 2015

HESS II
2012 - 2014

CANGAROO
1992 - 2011



CAT
1996 - 2002

VERITAS
2006 - 2013

CTA
2015

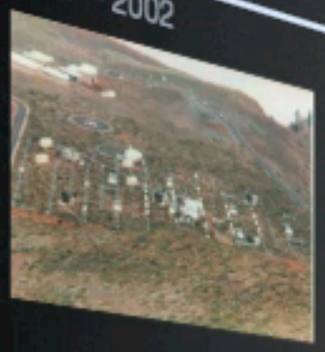
Whipple
1980

1990
1995
2000

Wednesday, August 28, 13

Whipple
1980

HEGRA
1987 – 2002



CANGAROO
1992 – 2011

2002

HESS
2002 – 2012

MAGIC
2003 – 2011

MAGIC II
2008 – 2015

HESS 2
2012 – 2015

VERITAS
2006 – 2013

CTA
2015

1980
1985
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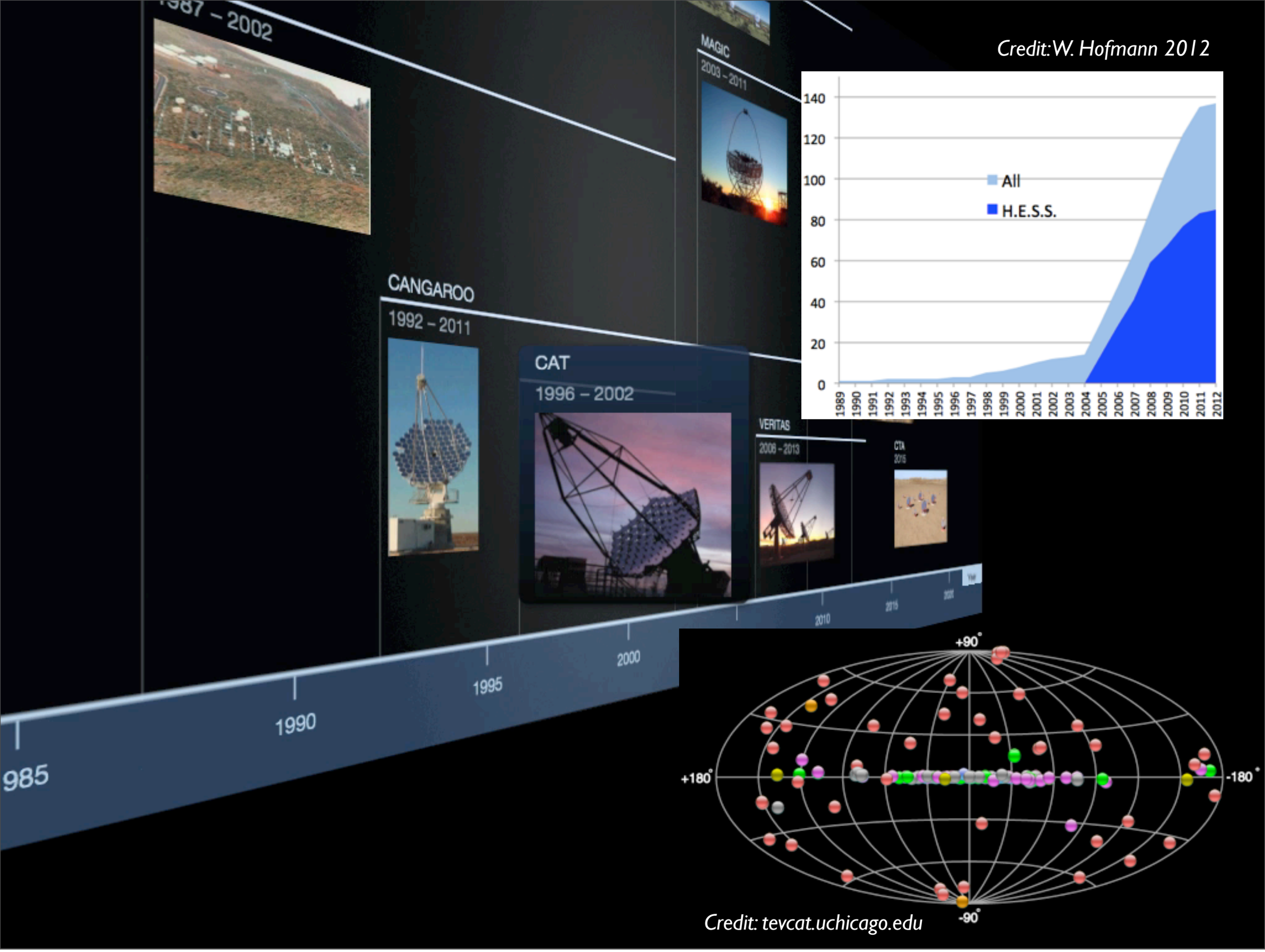
2020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CANGAROO
1992 – 2011
CAT
1996 – 2002
VERITAS
2006 – 2013
CTA
2015
1985
1990
1995
2000
2010
2015
2020
Credit:W. Hofmann 2012
140
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100
80
60
40
20
0
All
H.E.S.S.
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+90°
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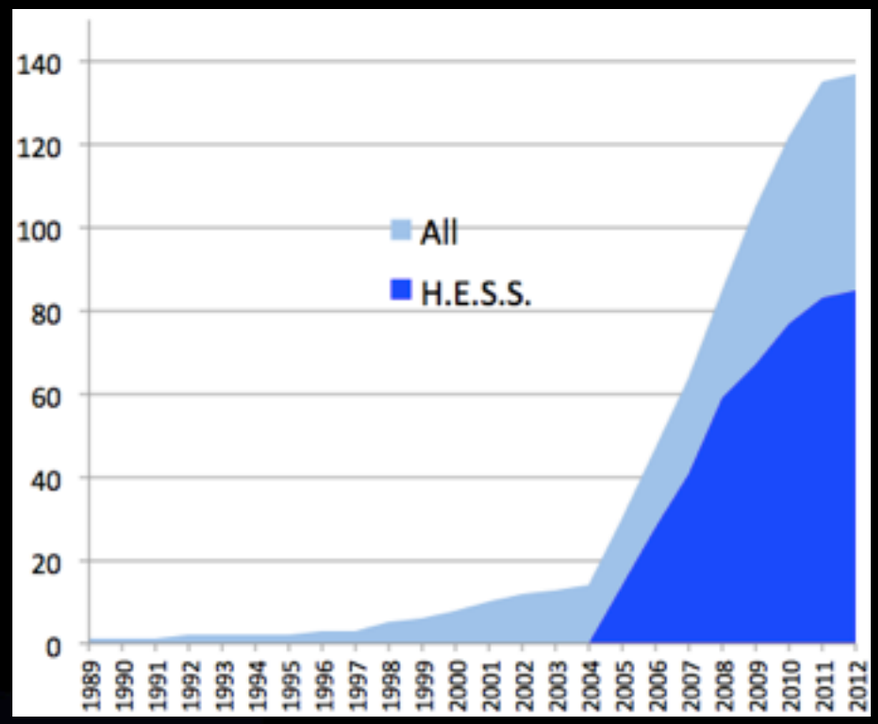
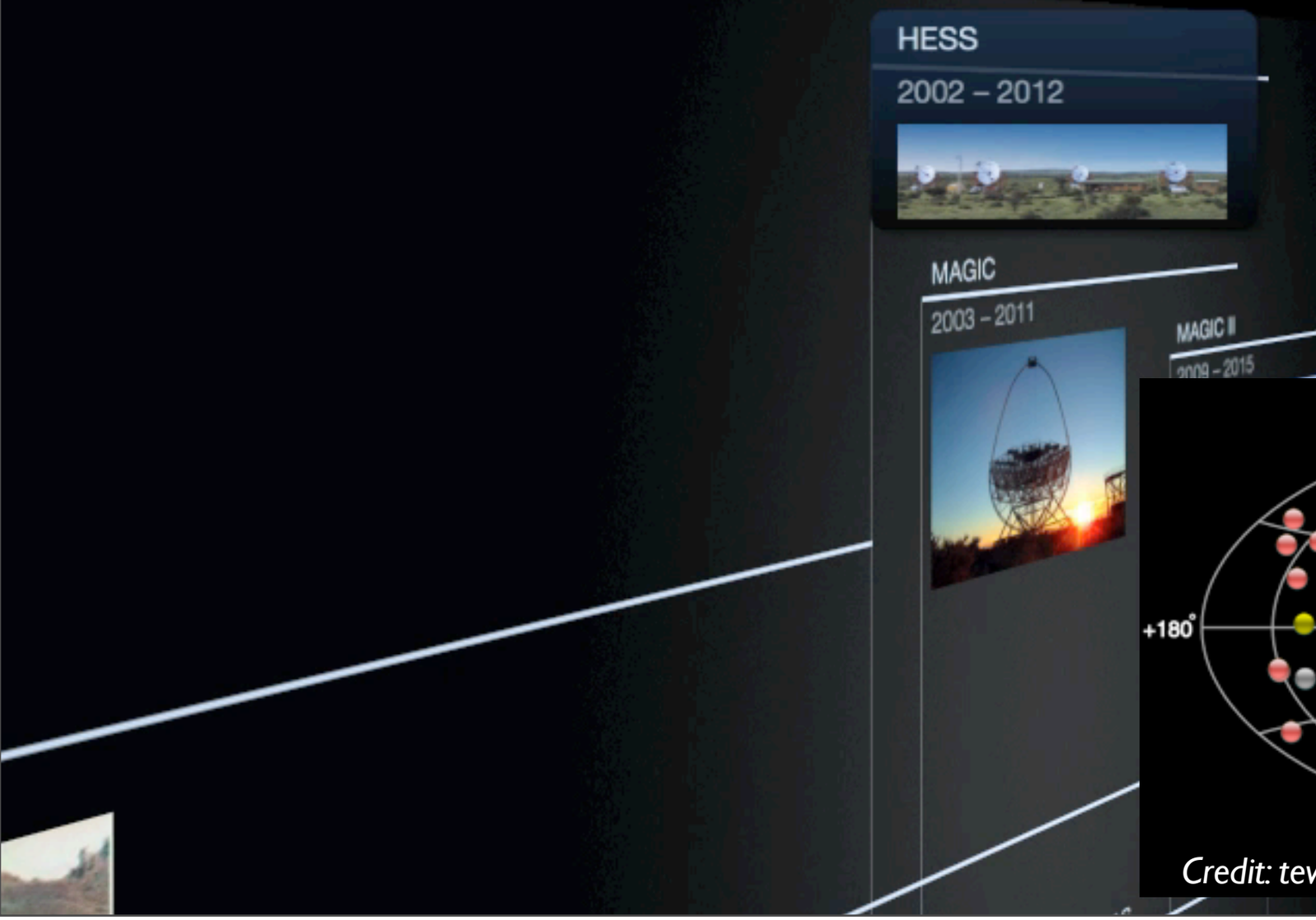
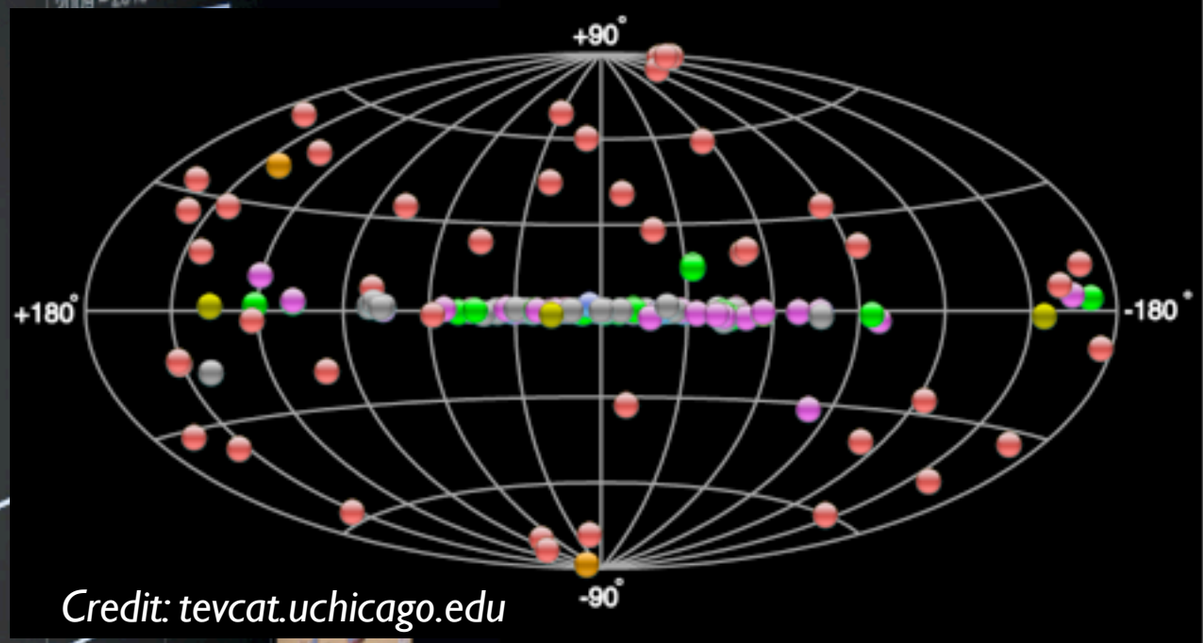
Credit: tevcat.uchicago.edu

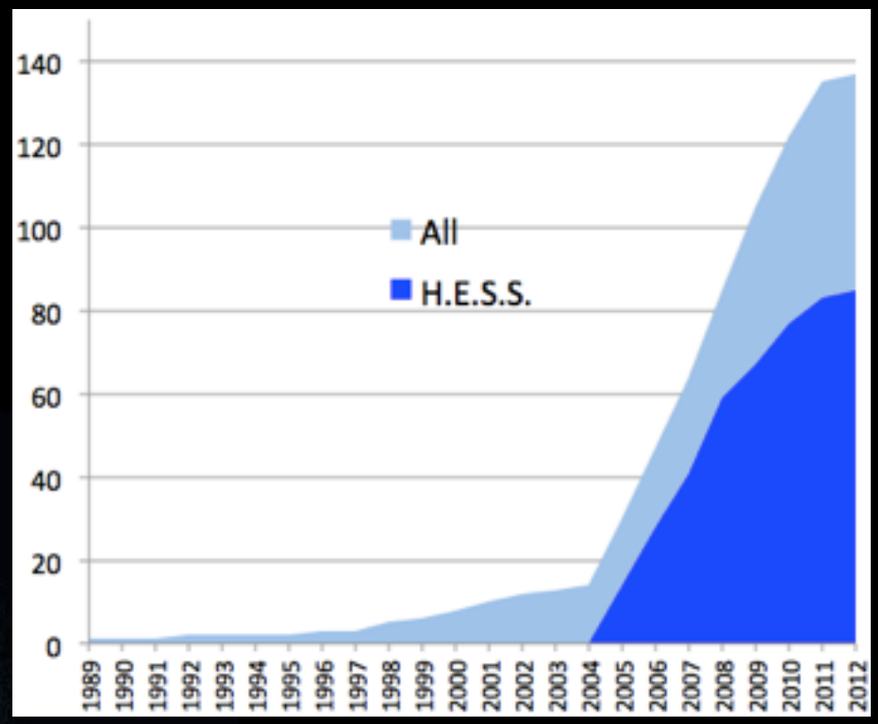
Credit:W. Hofmann 2012







Credit:W. Hofmann 2012



HESS
2002 – 2012

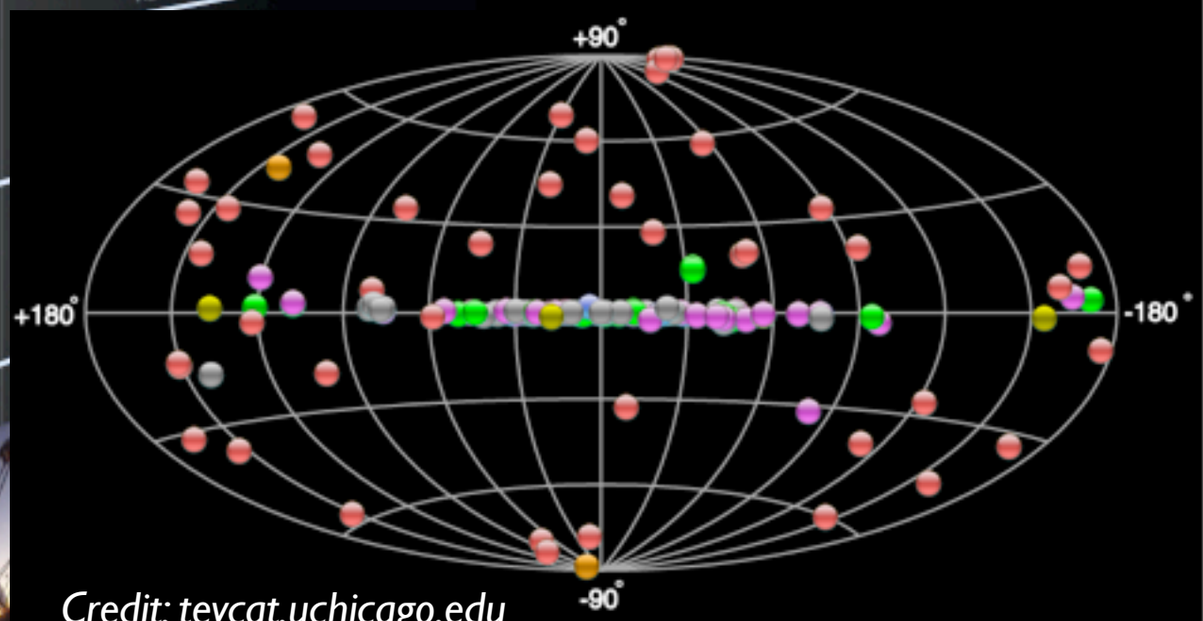
MAGIC
2003 – 2011

HESS 2

CANGAROO
1992 – 2011

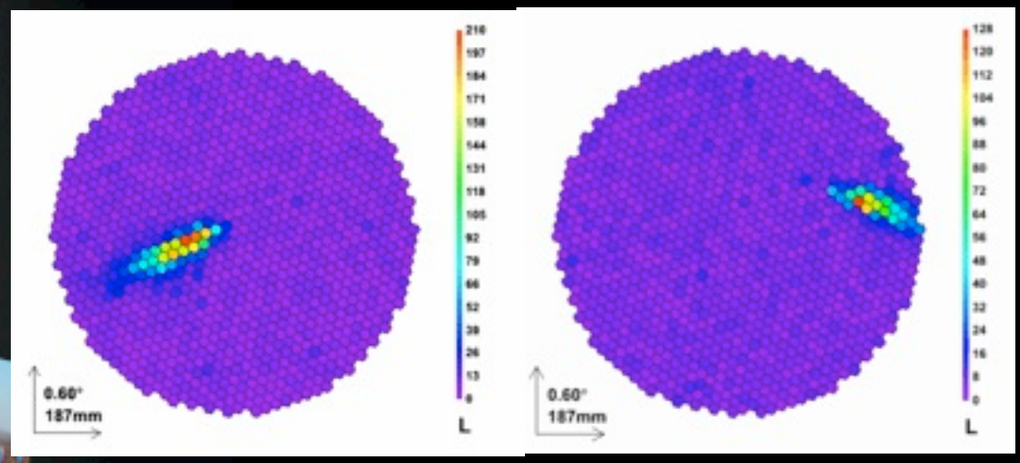
CAT
1996 – 2002

VERITAS
2006 – 2013



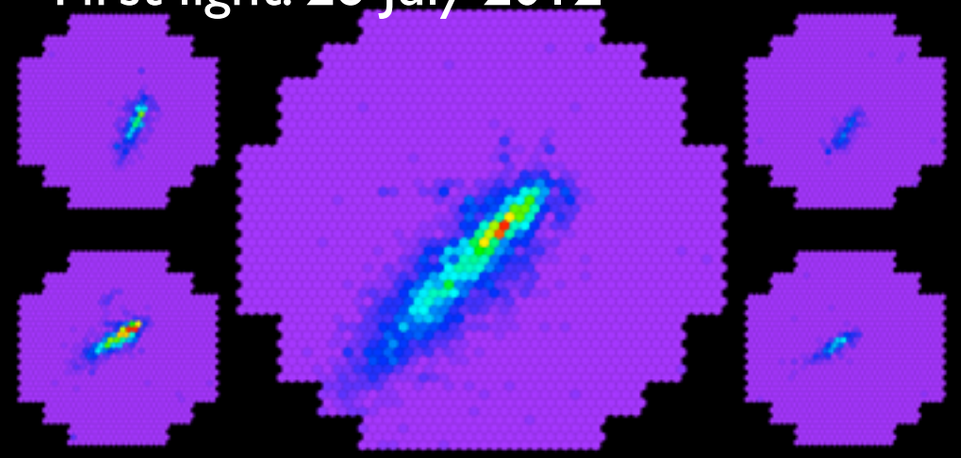
Credit: tevcat.uchicago.edu

First light: 24 Abril 2009
New camera: Summer 2012



A. Moralejo 2012

First light: 26 July 2012



HESS
2002 – 2012

MAGIC
2003 – 2011

MAGIC II
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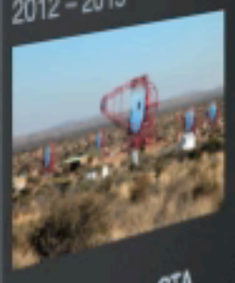
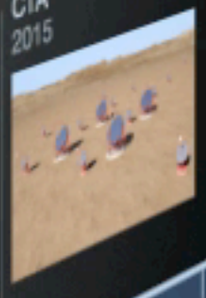
HESS 2
2012 – 2015



CTA
2015



VERITAS
2006 – 2013

2002

Year

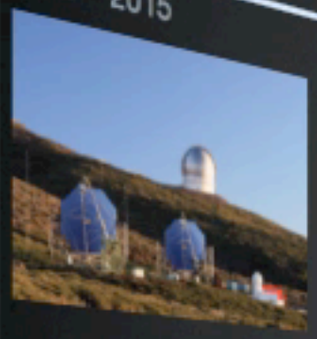
2020

MAGIC

2003 – 2011

MAGIC II

2009 – 2015



HESS 2

2012 – 2015

VERITAS

2006 – 2013

CTA

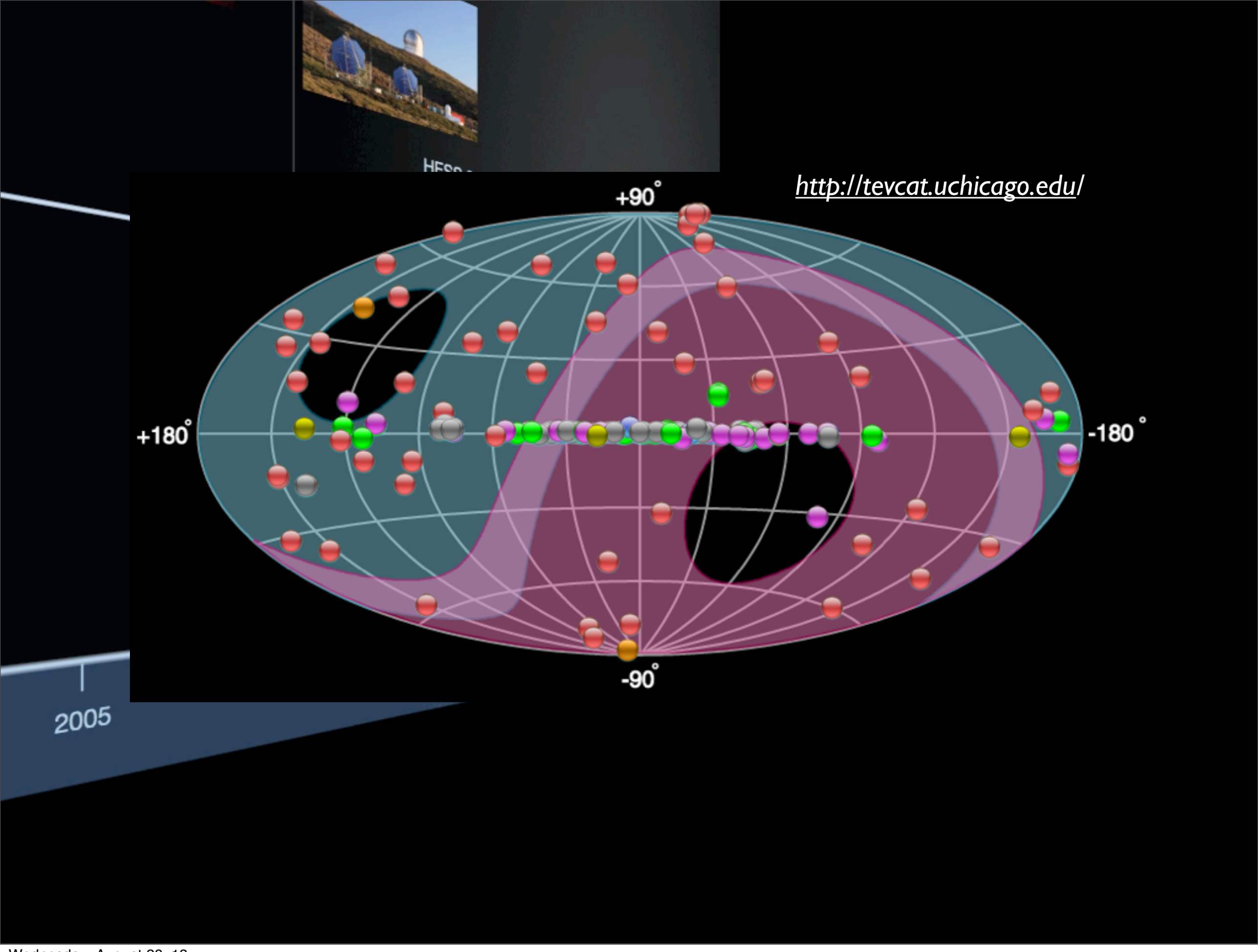
2015

2010

2015

2020

Year


http://tevcat.uchicago.edu/
+90°
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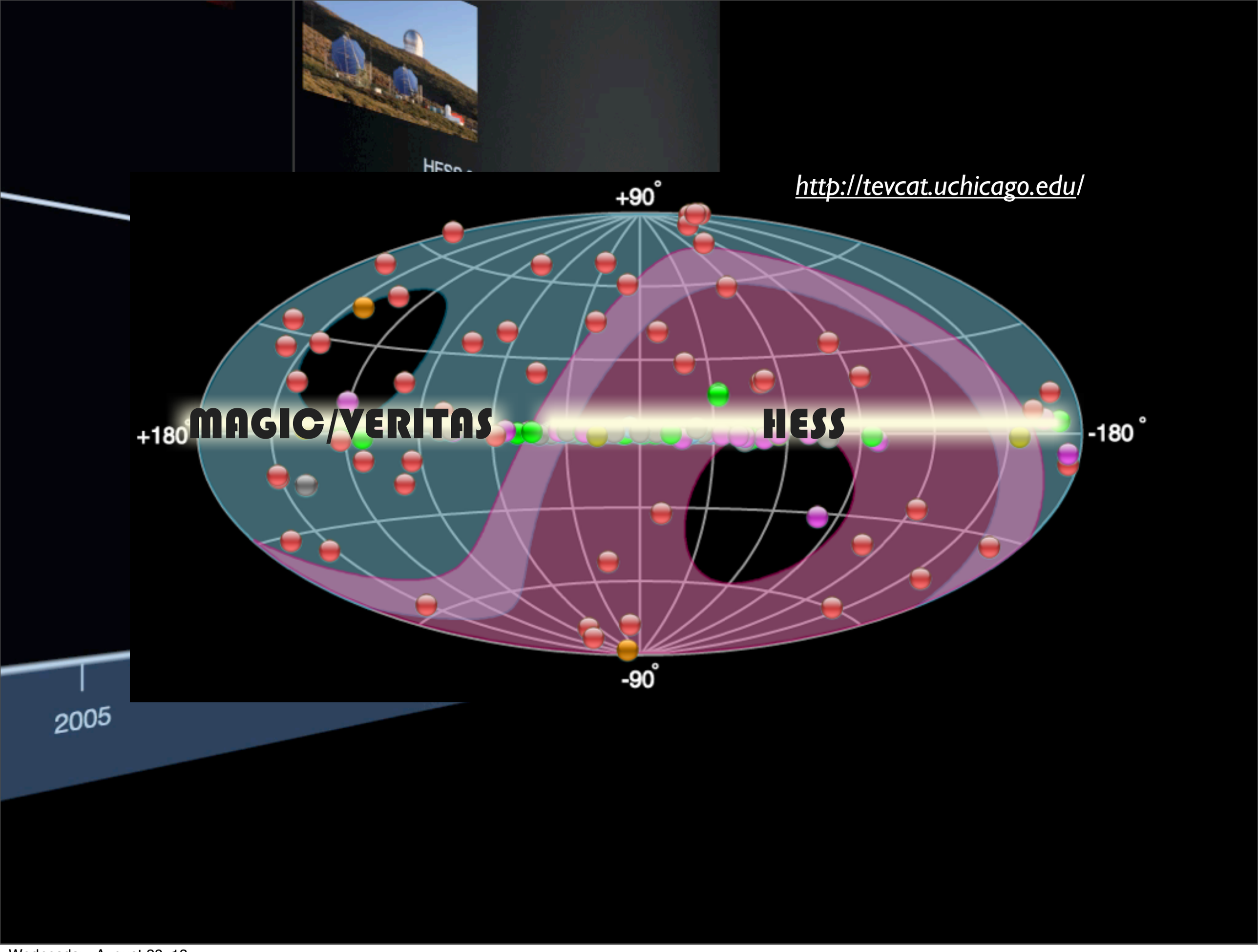
2005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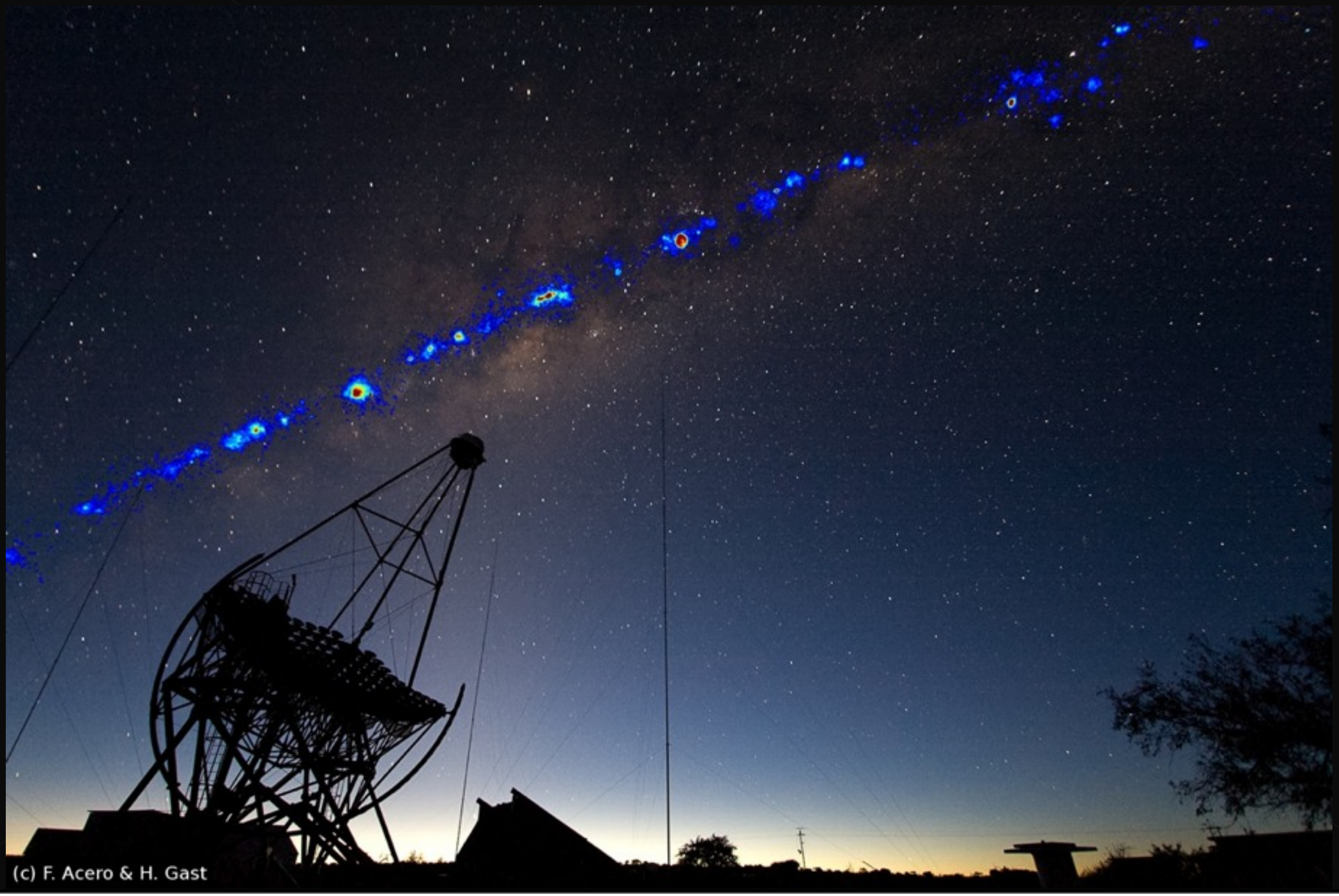
MAGIC/VERITAS
HESS
2005

The Population of TeV Galactic Sources



(J. Hinton)

Molecular Cloud

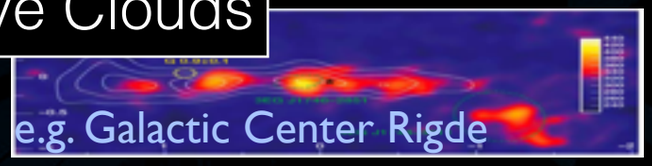
(J. Hinton)

Molecular Cloud

Nearby accelerator

yes

Active Clouds



e.g. Galactic Center Rigde

no

Passive Clouds

e.g. Fermi clouds

(J. Hinton)

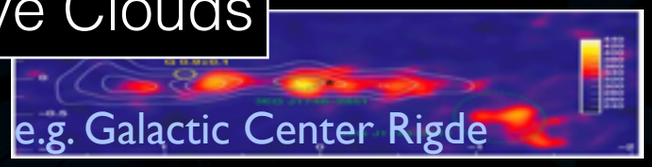
Molecular Cloud

Massive Star

Nearby accelerator

yes

Active Clouds



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(J. Hinton)

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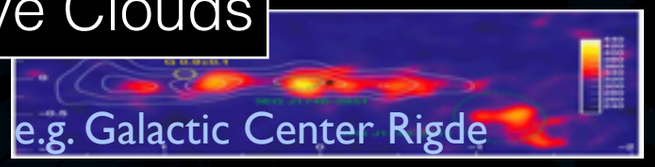


e.g. Galactic Center Rigde

no

Passive Clouds

e.g. Fermi clouds

In cluster?

yes

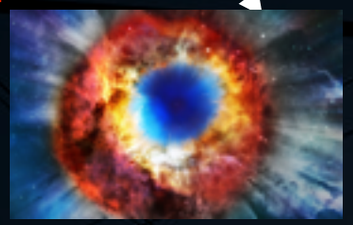
Collective interactions

e.g. Westerlund 1

no

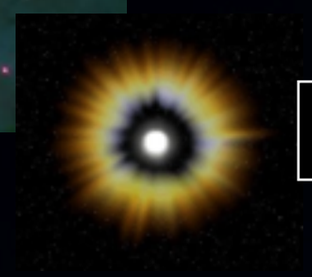
No VHE expected until...

Supernova



(J. Hinton)

Molecular Cloud



Massive Star

Binary?

yes

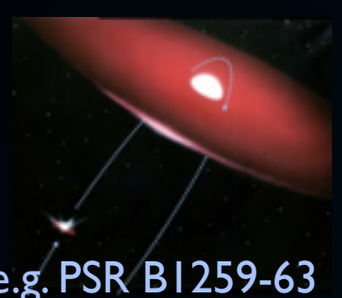
Compact companion?

yes

Neutron star?

yes

Binary PWNe



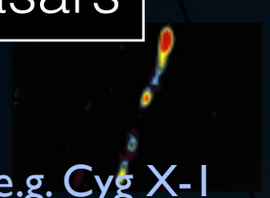
e.g. PSR B1259-63

no

radio jets?

yes

Microquasars



e.g. Cyg X-1

no

Massive companion?

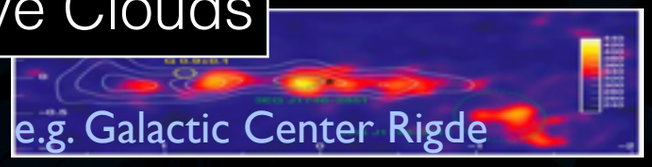
Colliding wind sys.

e.g. Eta Carina

Nearby accelerator

yes

Active Clouds



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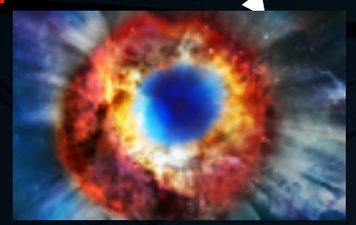

e.g. Westerlund 1

(J. Hinton)

Molecular Cloud

Nearby accelerator

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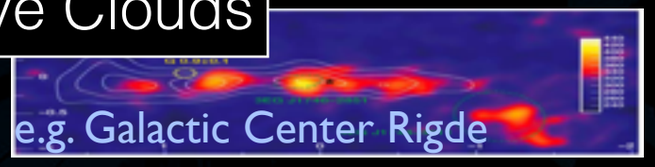
Active Clouds



no

Passive Clouds

e.g. Fermi clouds

Massive Star

In cluster?

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Collective interactions

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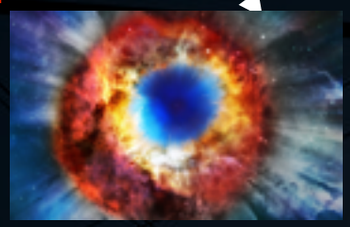


Neutron star remains?

yes

Neutron star?

yes

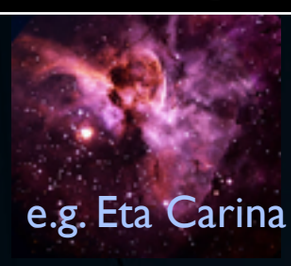
Binary PWNe

no

radio jets?

Massive companion?

Colliding wind sys.

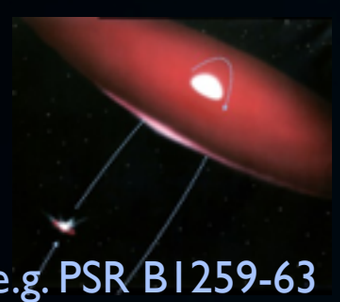


no

SNR Shell

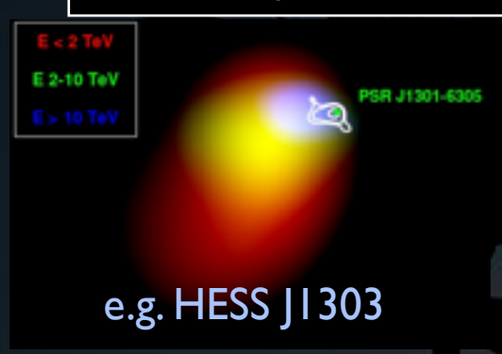
PWN outlasts or escapes SNR

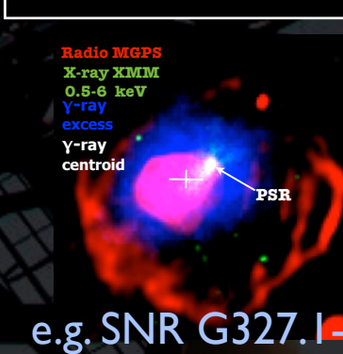
Composite SNR

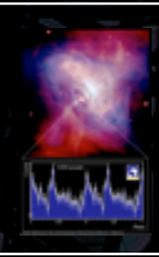


yes

Microquasars







e.g. Crab!

Pulsar

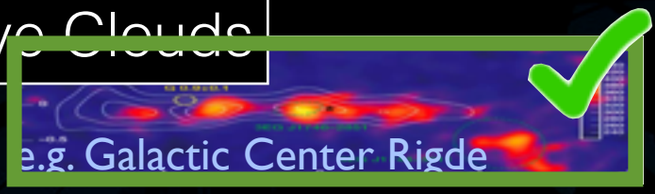
(J. Hinton)

Molecular Cloud

Nearby accelerator

yes

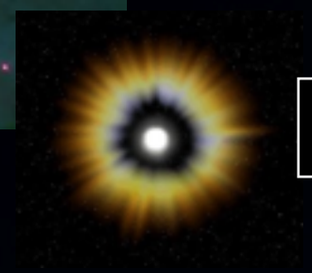
Active Clouds



no

Passive Clouds

e.g. Fermi clouds



Massive Star

In cluster?

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Collective interactions

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Binary?

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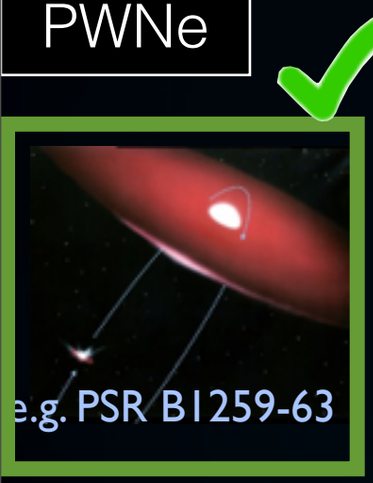


no

radio jets?

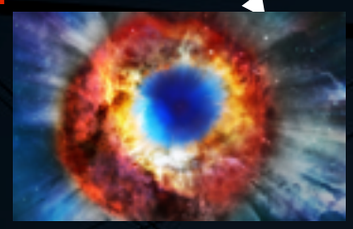
yes

Microquasars

Massive companion?

Colliding wind sys.

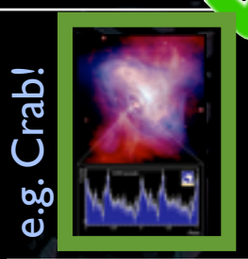
Supernova



Neutron star remains?

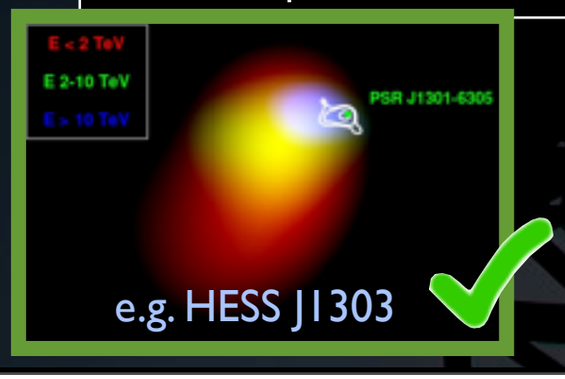
no

yes

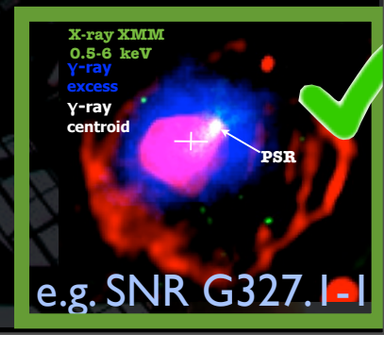


SNR Shell

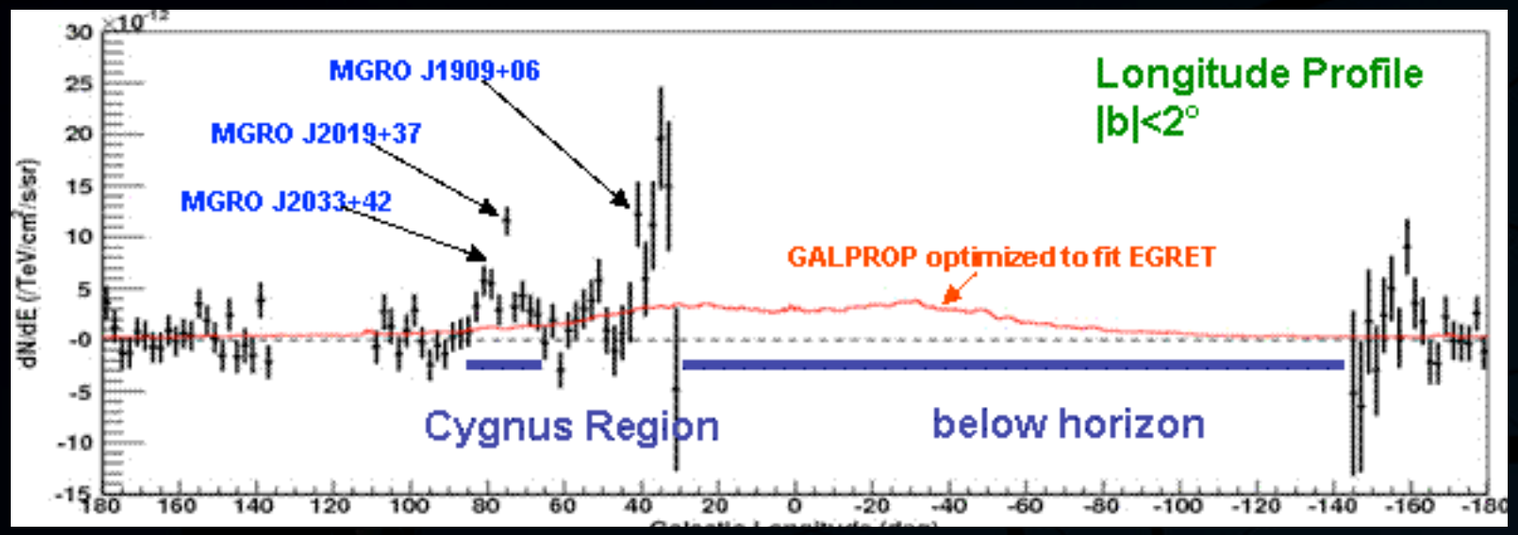
PWN outlasts or escapes SNR



Composite SNR



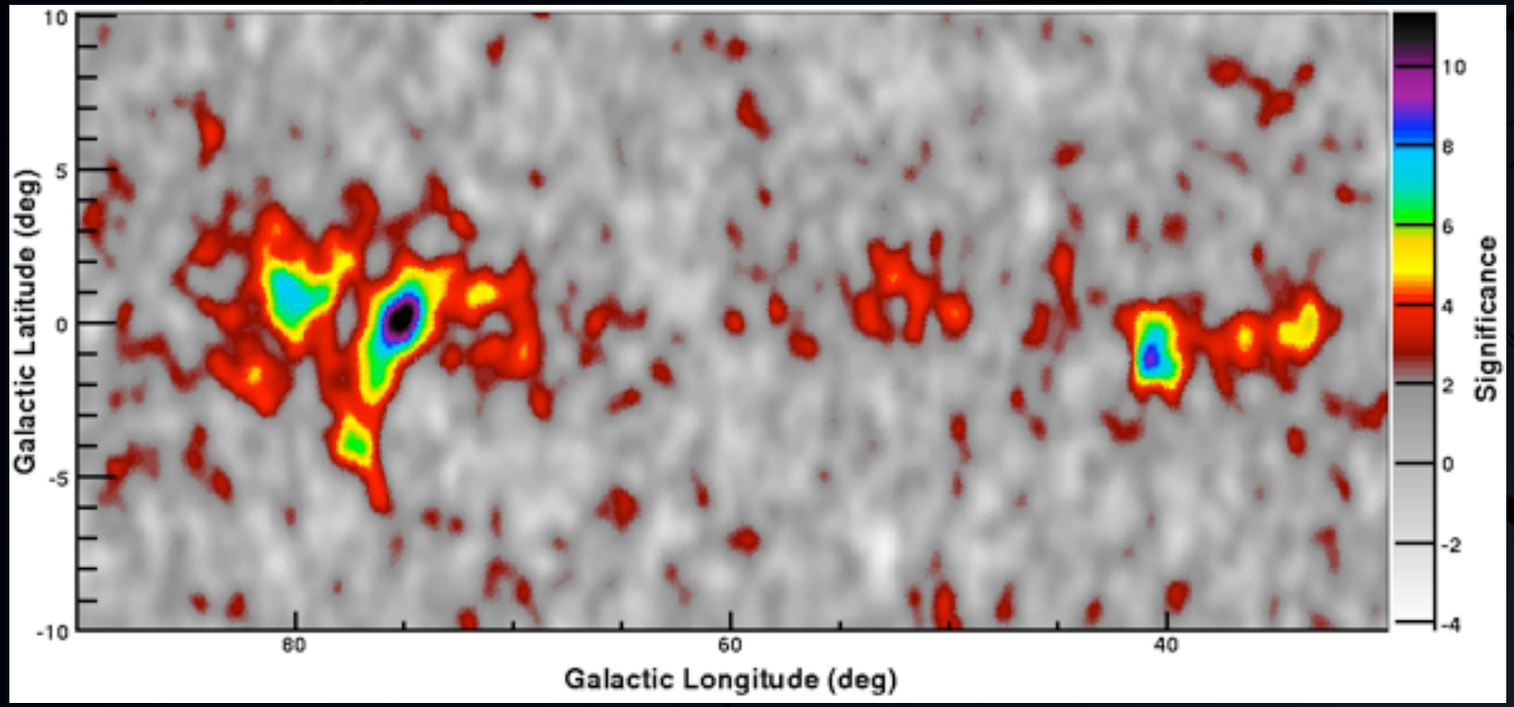
TeV Galactic Surveys

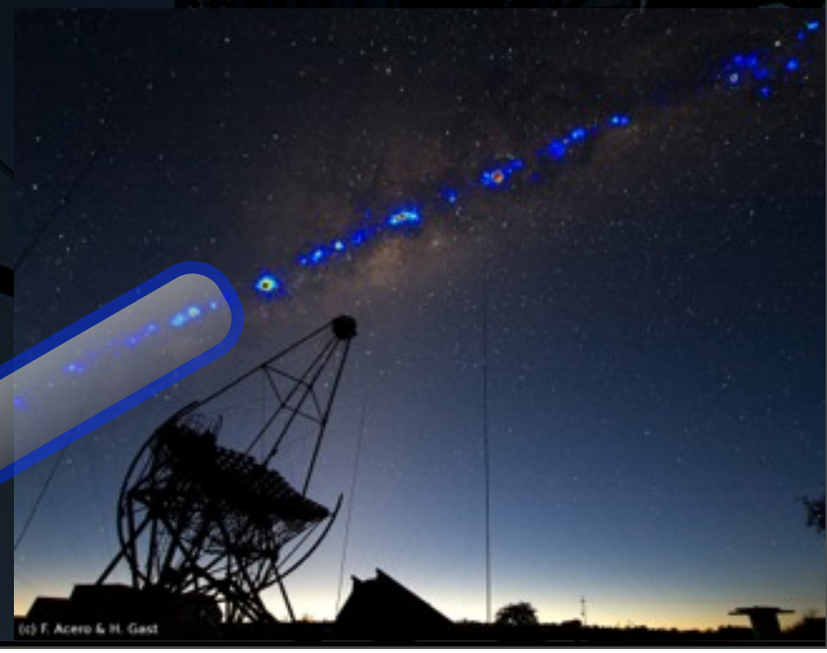


MILAGRO

Particle/Water Cherenkov Detectors

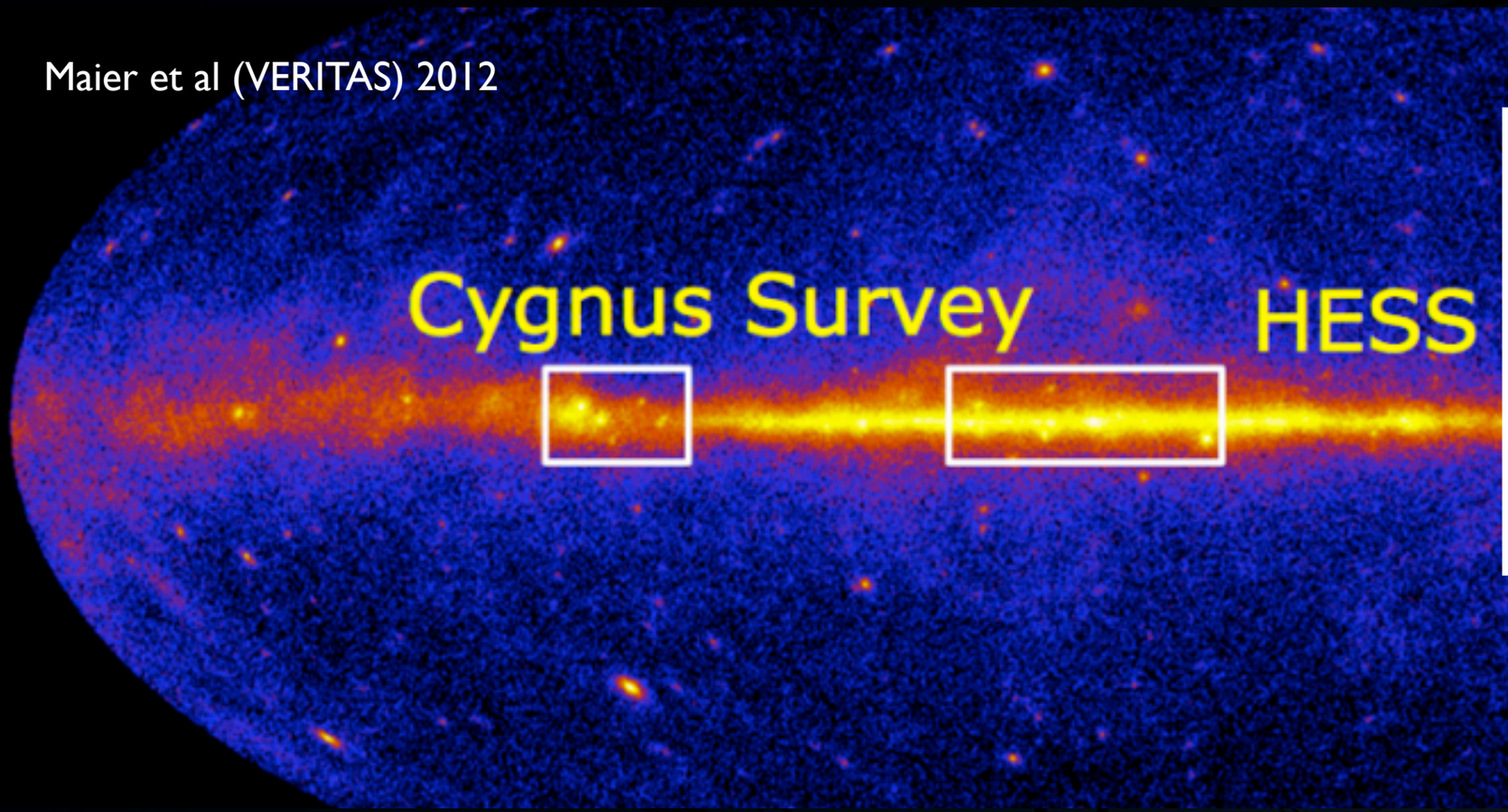
Energy range **1-100 TeV**
Area **> 10^4 m²**
Background Rejection **> 95%**
Angular Resolution **~0.3-0.7°**
Aperture **> 2 sr**
Duty cycle **90%**





TeV Galactic Surveys

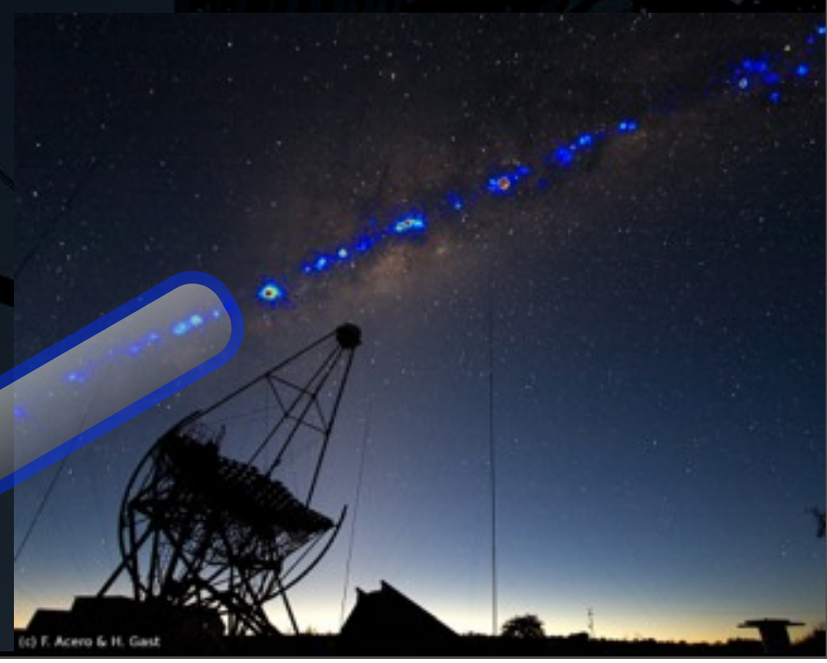
Maier et al (VERITAS) 2012



Air Cherenkov Telescopes

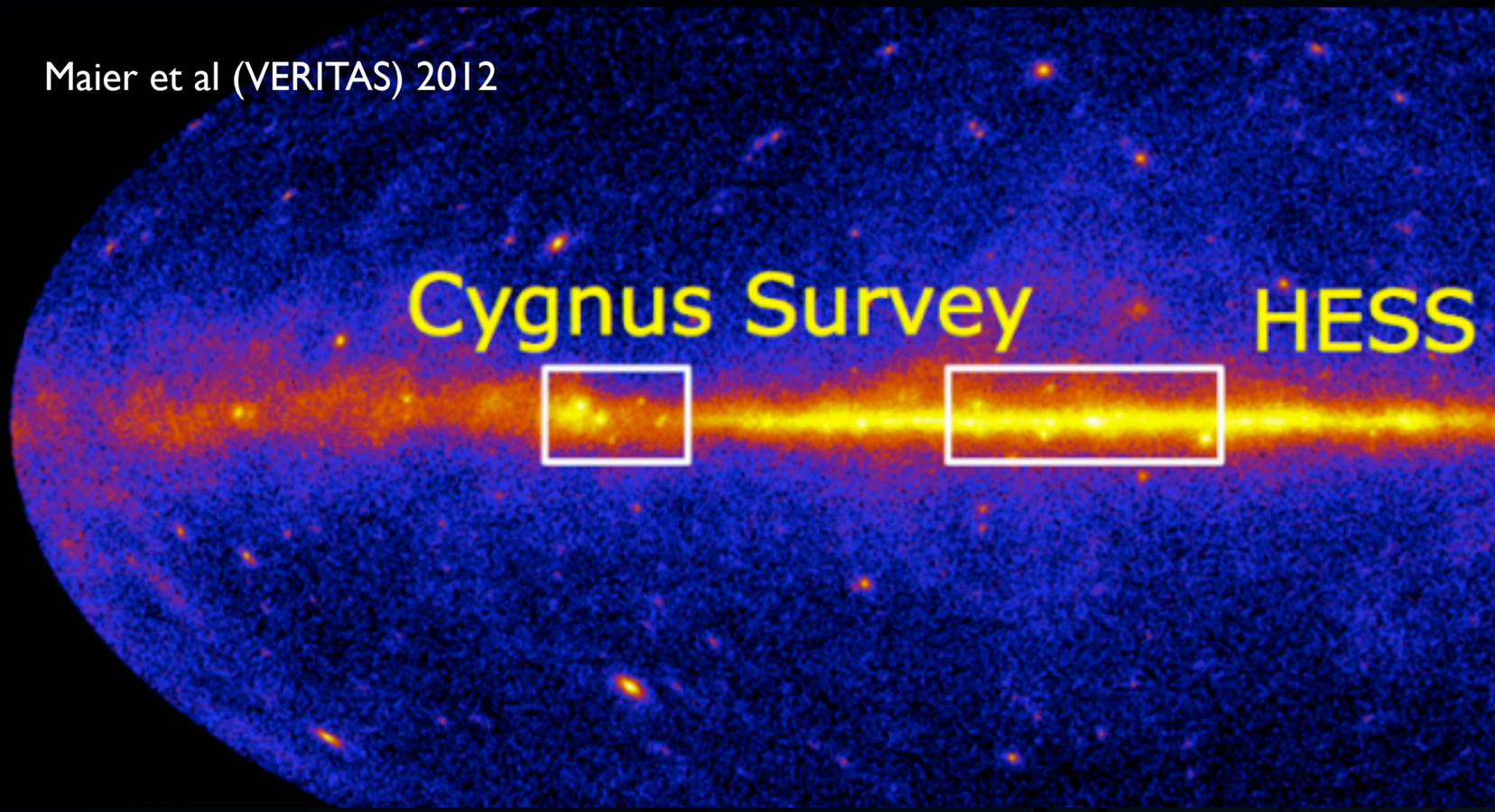
Energy range **0.05-50 TeV**
Area **> 10^4 m^2**
Background Rejection **> 99%**
Angular Resolution **~0.05°**
Aperture **0.003 sr**
Duty cycle **10%**

*See also contribution by F. Sheidaei and R. Gozzini



TeV Galactic Surveys

Maier et al (VERITAS) 2012



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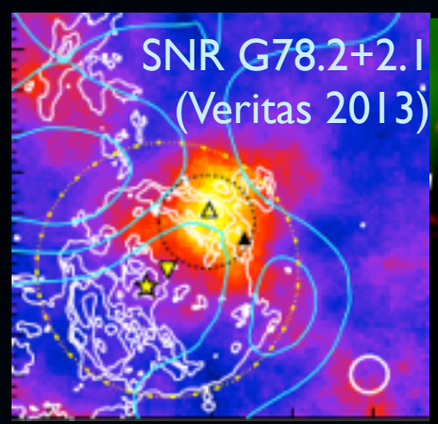
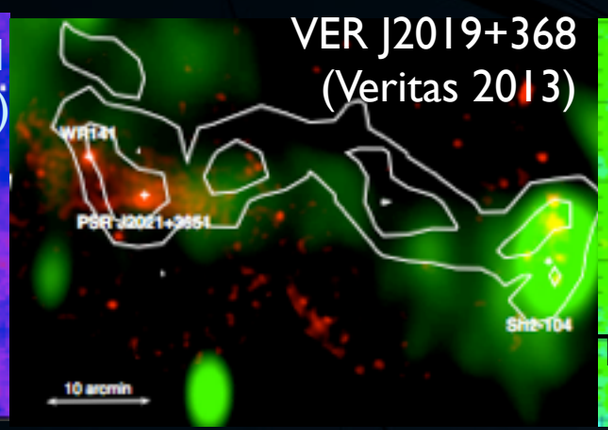
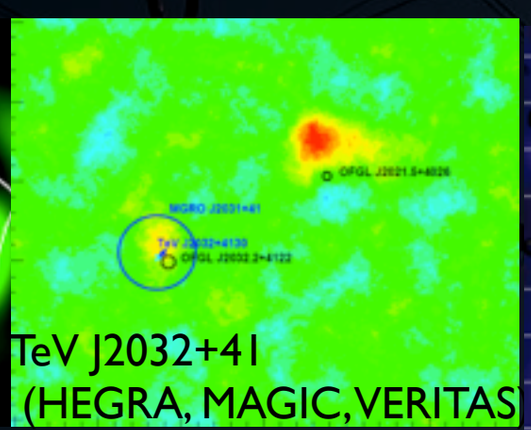
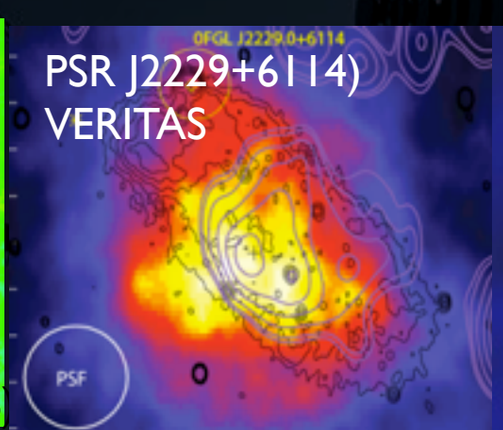
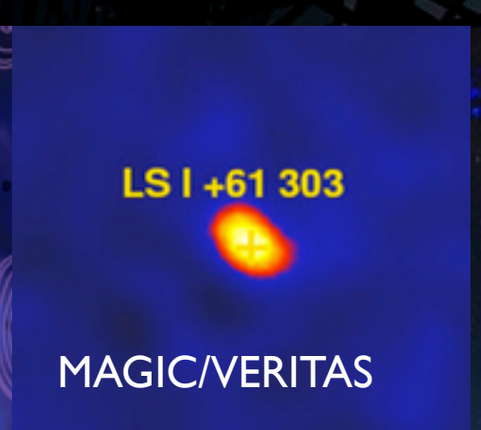






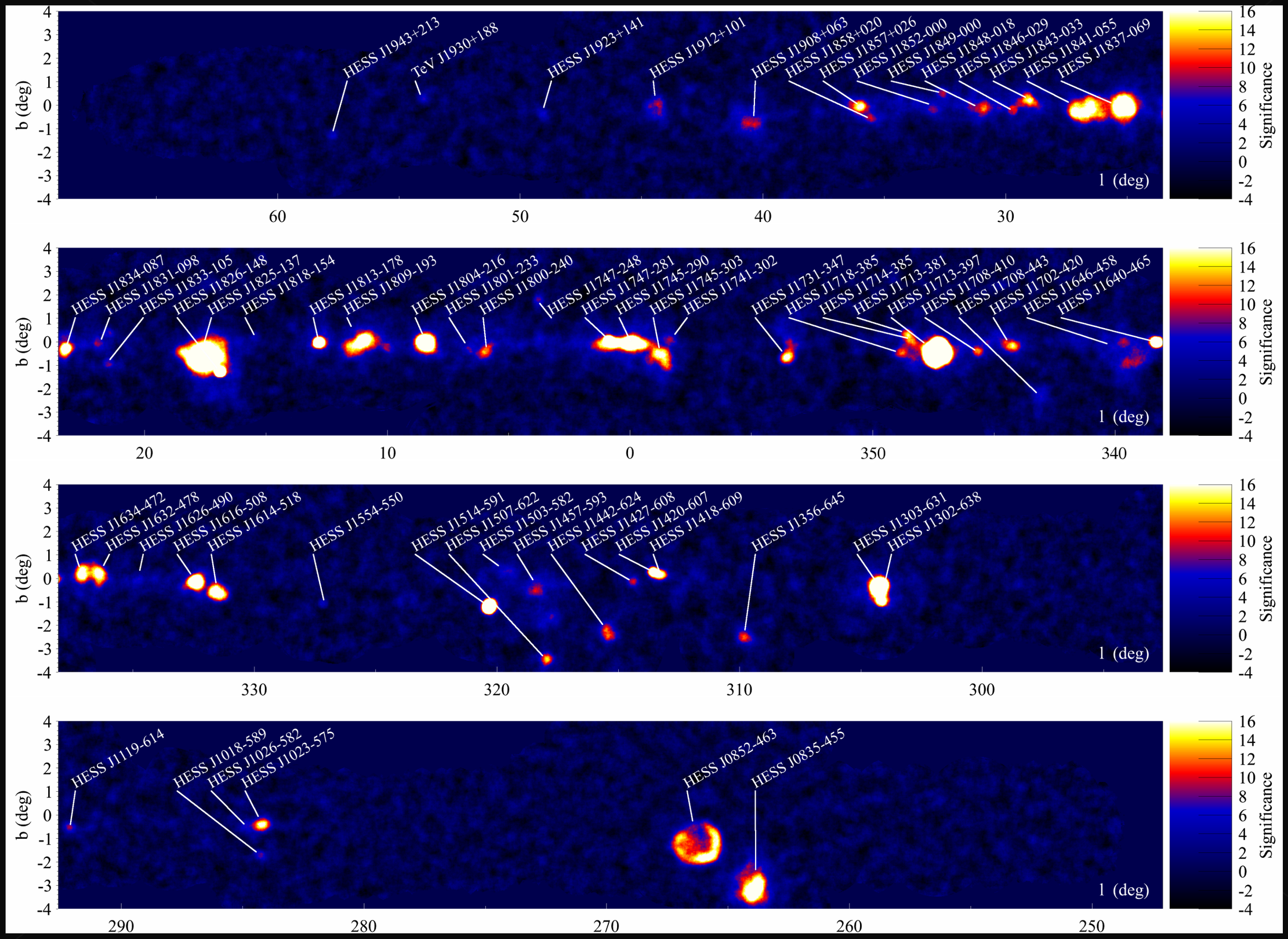




*See also contribution by F. Sheidaei and R. Gozzini

*See also contribution by C. Deil

The Inner Galaxy

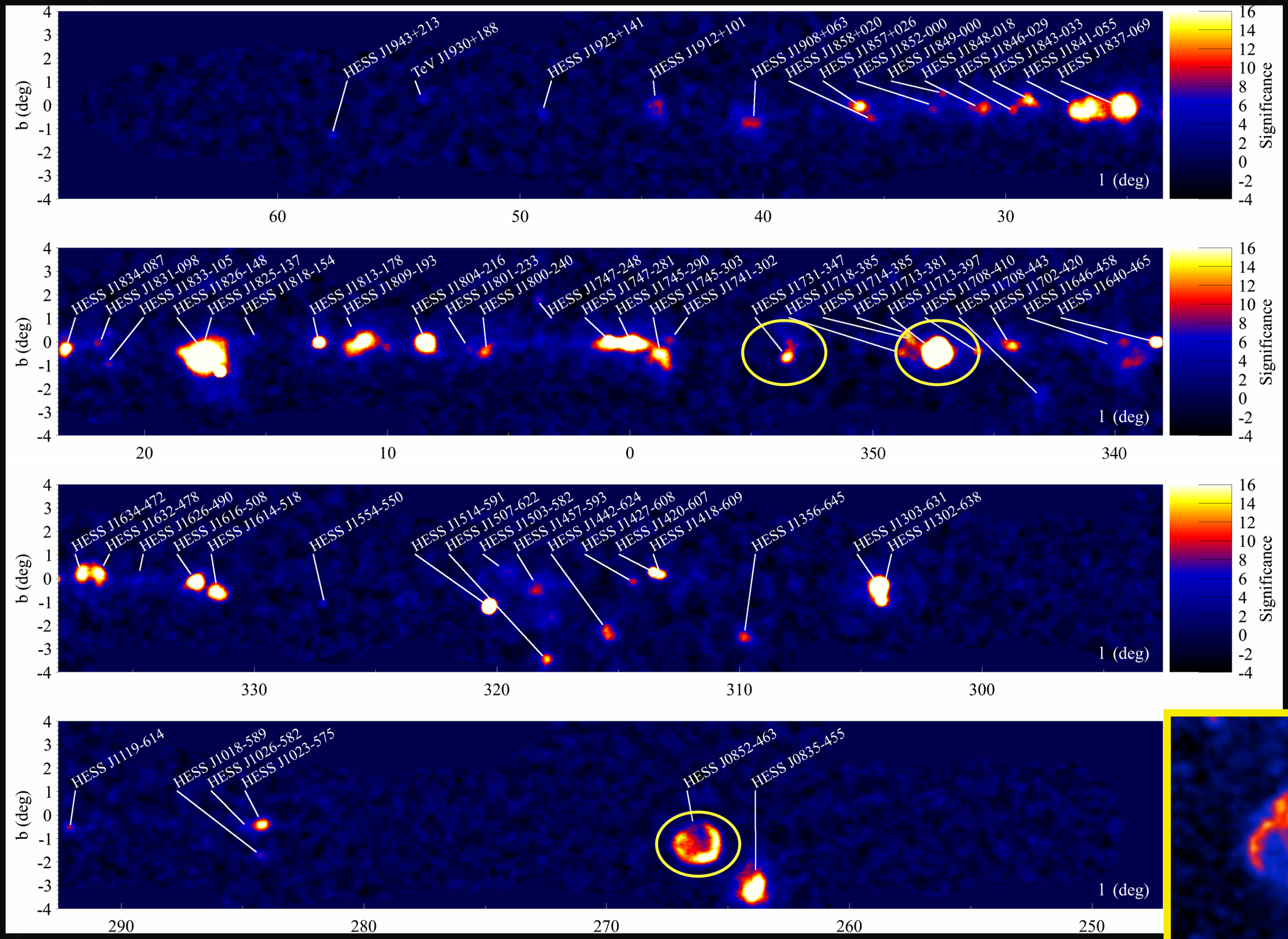


H.E.S.S. Collaboration 2011

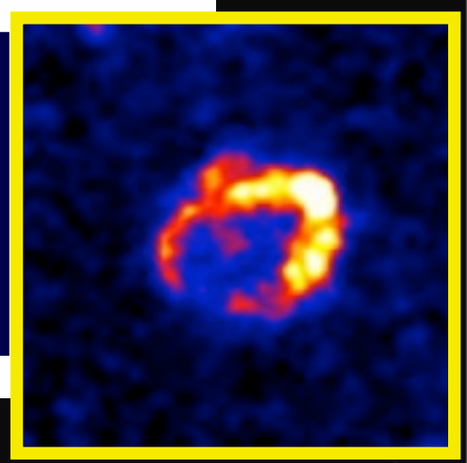
Gast et al, 2011

*See also contribution by C. Deil

The Inner Galaxy



H.E.S.S. Collaboration 2011

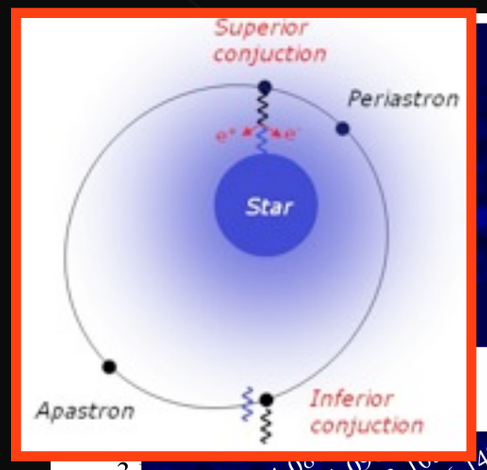


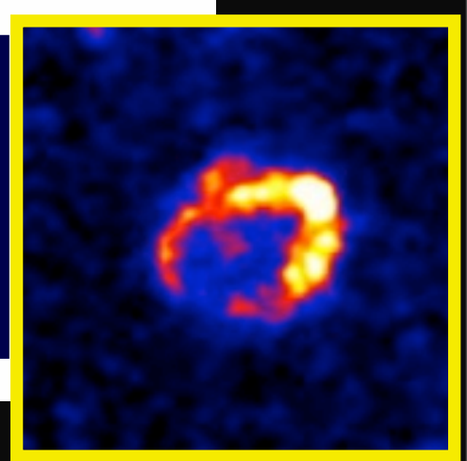
SNR

*See also contribution by C. Deil

The Inner Galaxy

Binaries





SNR

H.E.S.S. Collaboration 2011

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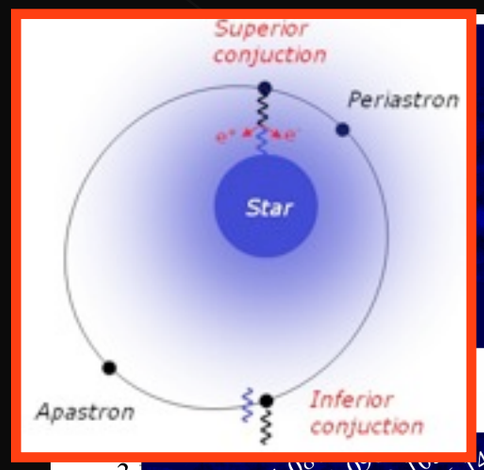
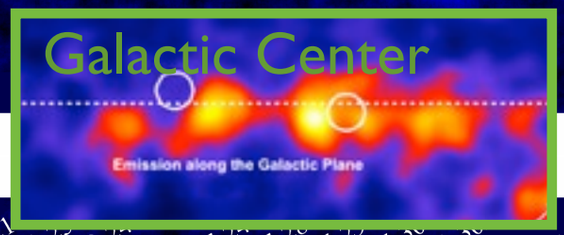
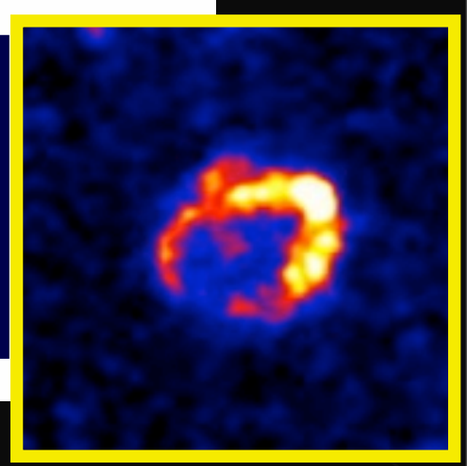
The Inner Galaxy

Binaries







SNR

H.E.S.S. Collaboration 2011

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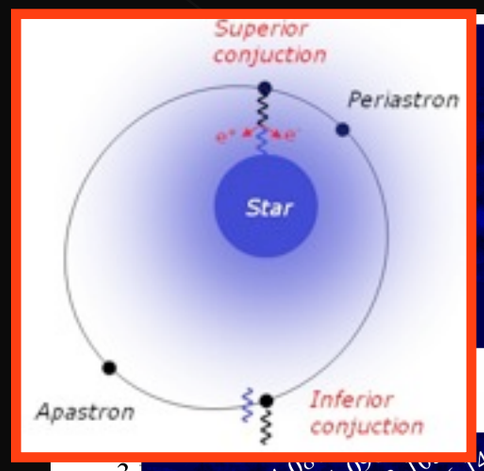
The Inner Galaxy

Binaries



H.E.S.S. Collaboration 2011

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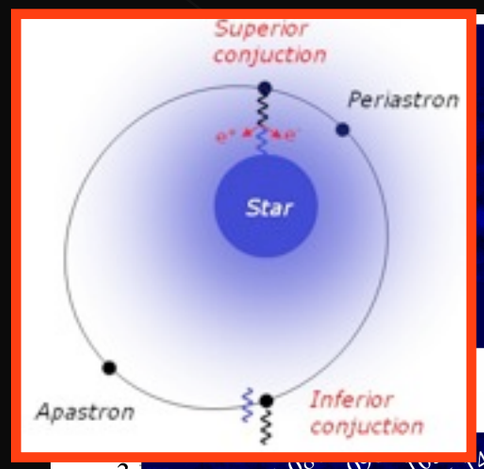
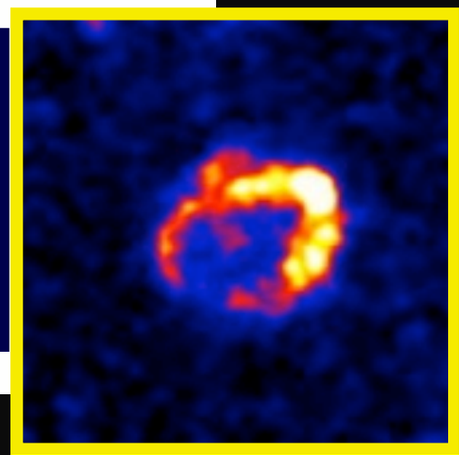
The Inner Galaxy

Binaries



Plerions/Dark



SNR

H.E.S.S. Collaboration 2011

*See also contribution by C. Deil

The Inner Galaxy

H.E.S.S. GPS will be soon to be released

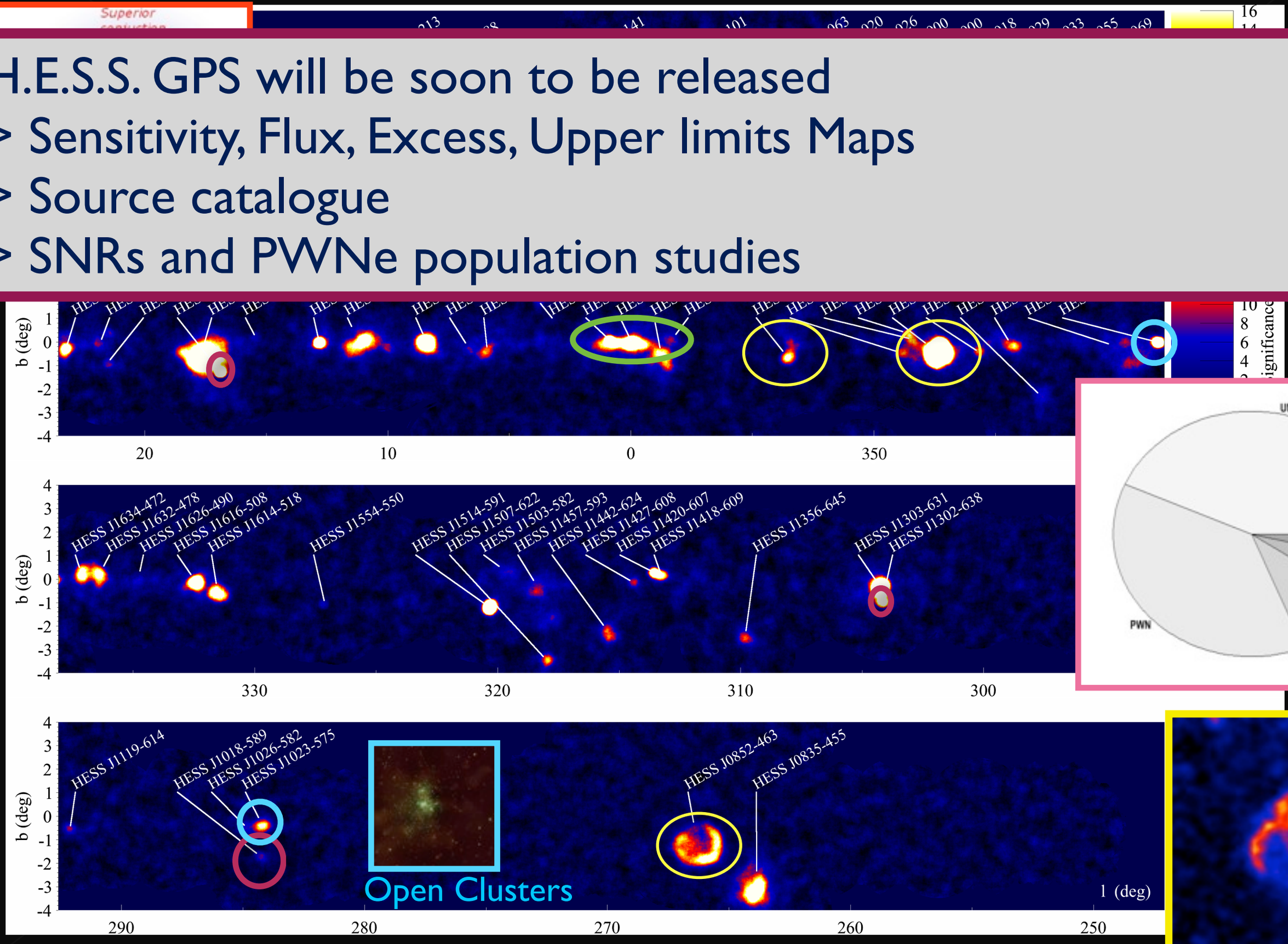
> Sensitivity, Flux, Excess, Upper limits Maps

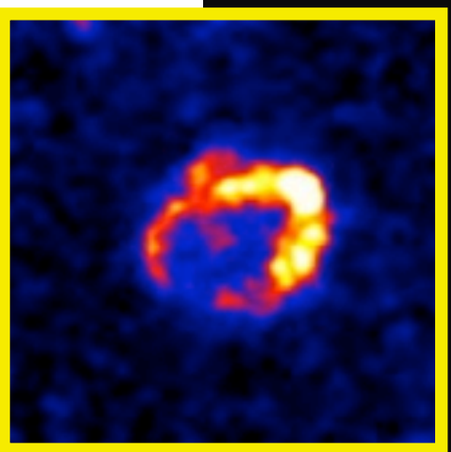
> Source catalogue

> SNRs and PWNe population studies

Binaries

Pleri



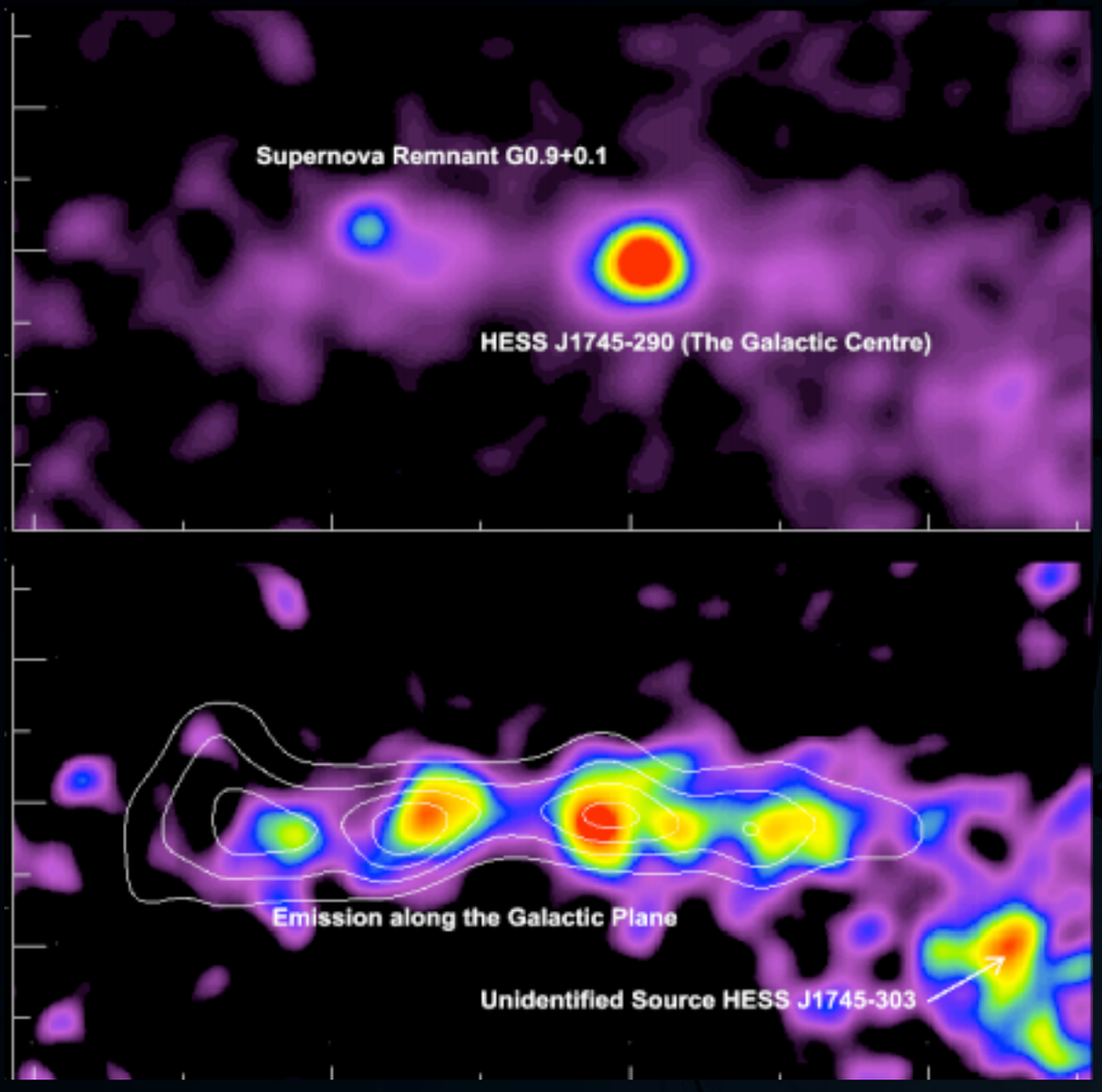


SNR

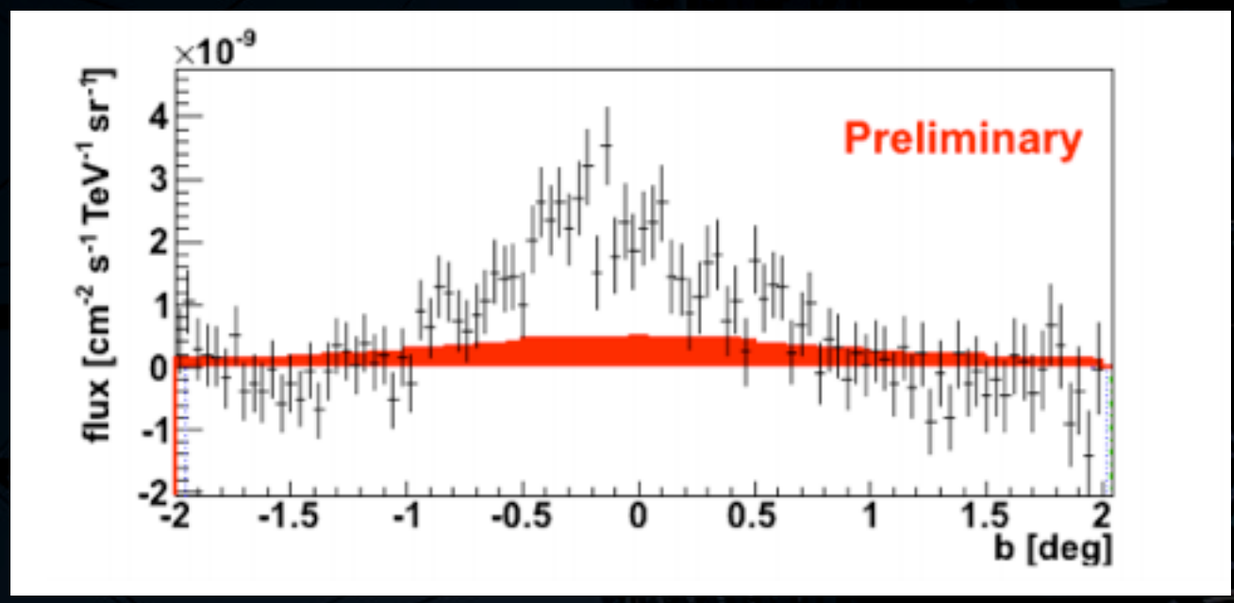
H.E.S.S. Collaboration 2011

Galactic Diffuse Emission

*See also contribution by C. Deil



HESS: Aharonian et al., 2006,2007



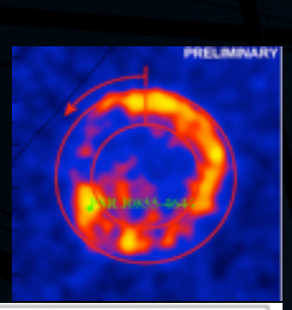
HESS: ICRC 2013

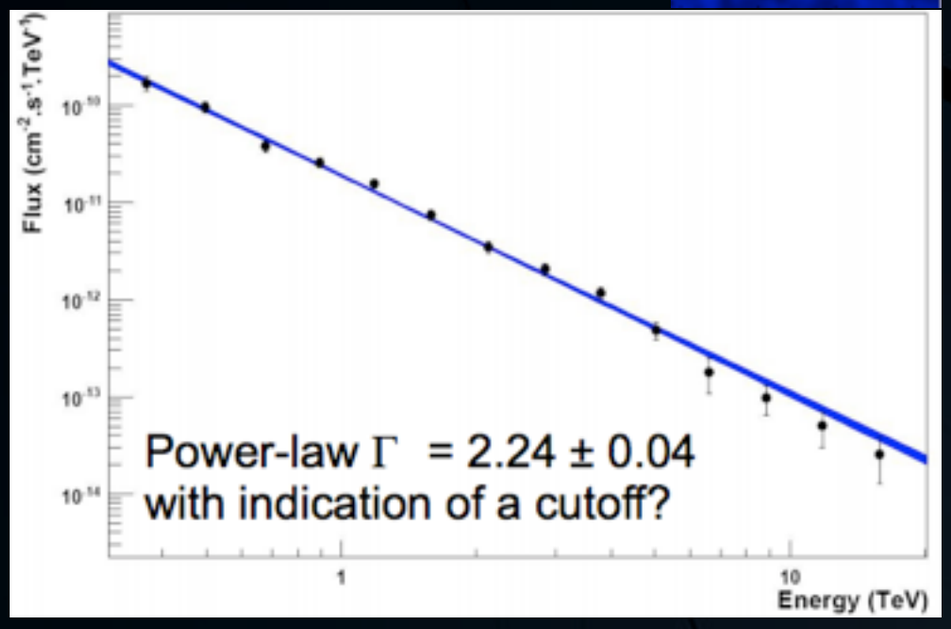
Source Type: Shell-Type Supernova Remnants

- Many SNRs detected and well-study at lower energy ranges (evolution, magnetic fields, composition, etc....)
- Galactic CR luminosity = $L_{CR} \sim 10^{41}$ erg/s → $\eta_{CR} \sim 0.1 \times (R_{SN}/0.03\ yr^{-1}) \times (10^{51}\ erg/E_{SN})$
- Why is it important to observe SNRs at VHE
  - > VHE trace the particle distribution, independently of the magnetic field
  - > Origin of Cosmic Rays! -> direct evidence for GeV-PeV (e,p) being accelerated at front shocks

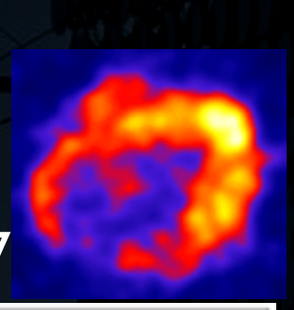
- Direct observation of the known shells seems to elude PeV particles

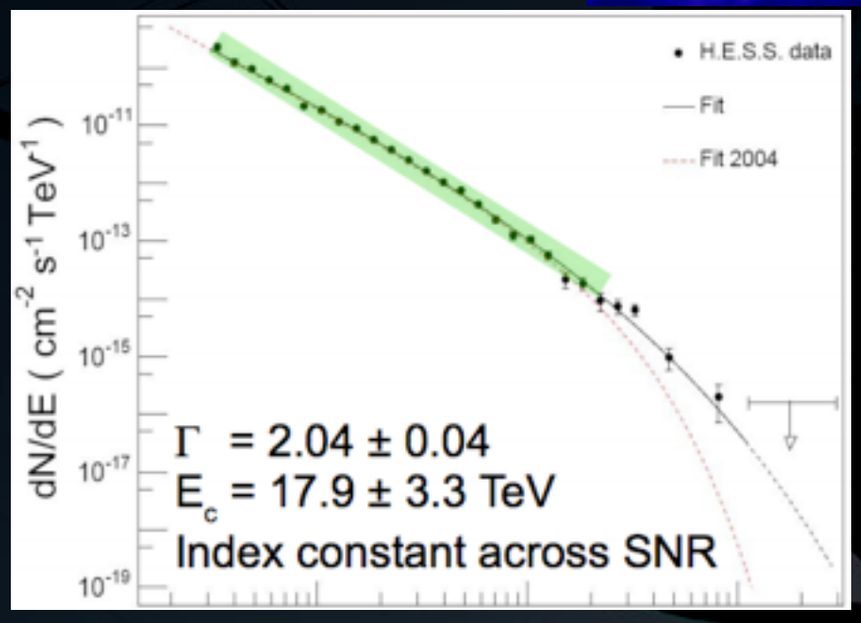
Vela Jr





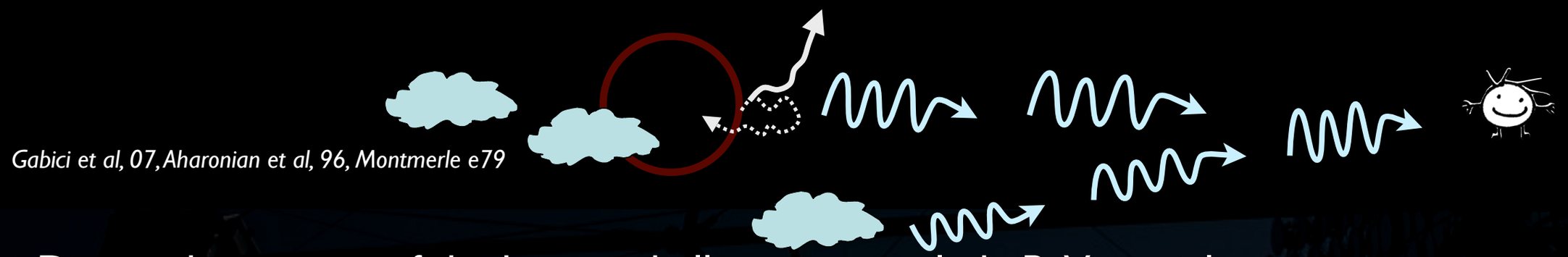
RX J1713.7-3947





Source Type: Shell-Type Supernova Remnants

BUT! PeV particles are believed to be accelerated at the beginning of Sedov phase (~200yrs), when the shock speed is high!
Look deeper at the surroundings of the SNR for very-high-energy run-away particles



Gabici et al, 07, Aharonian et al, 96, Montmerle e79

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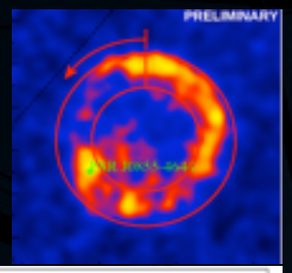
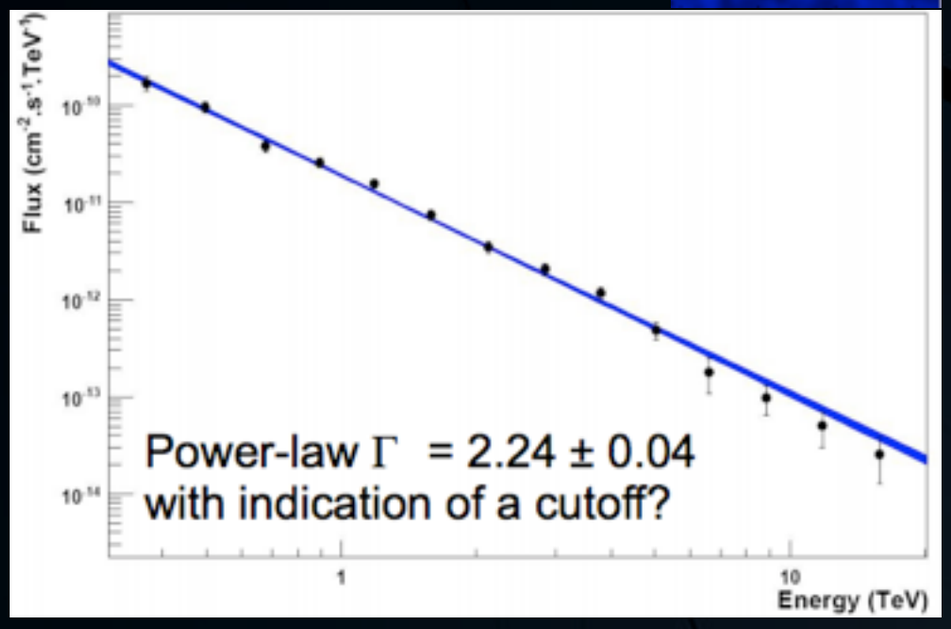
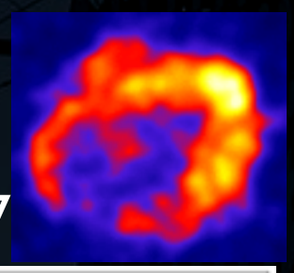
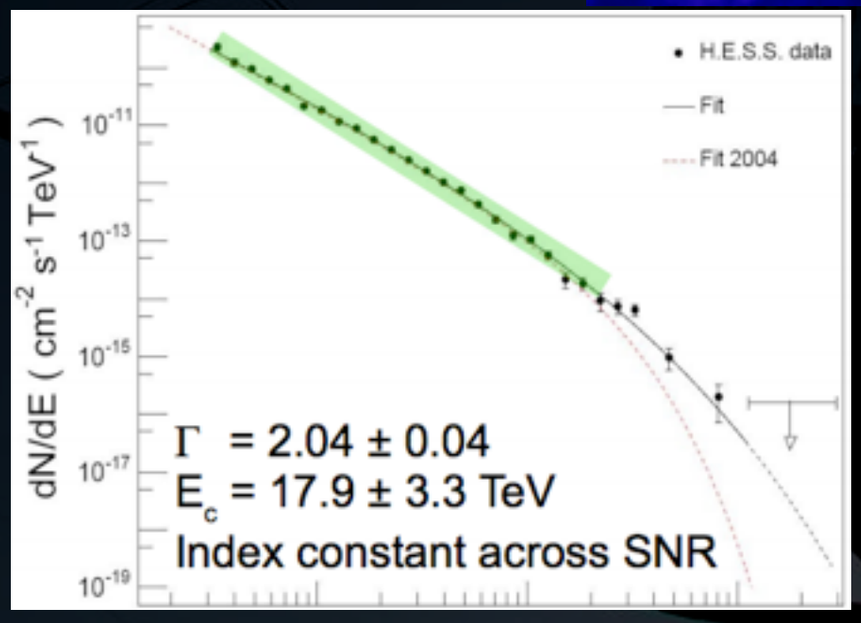




RX J1713.7-3947

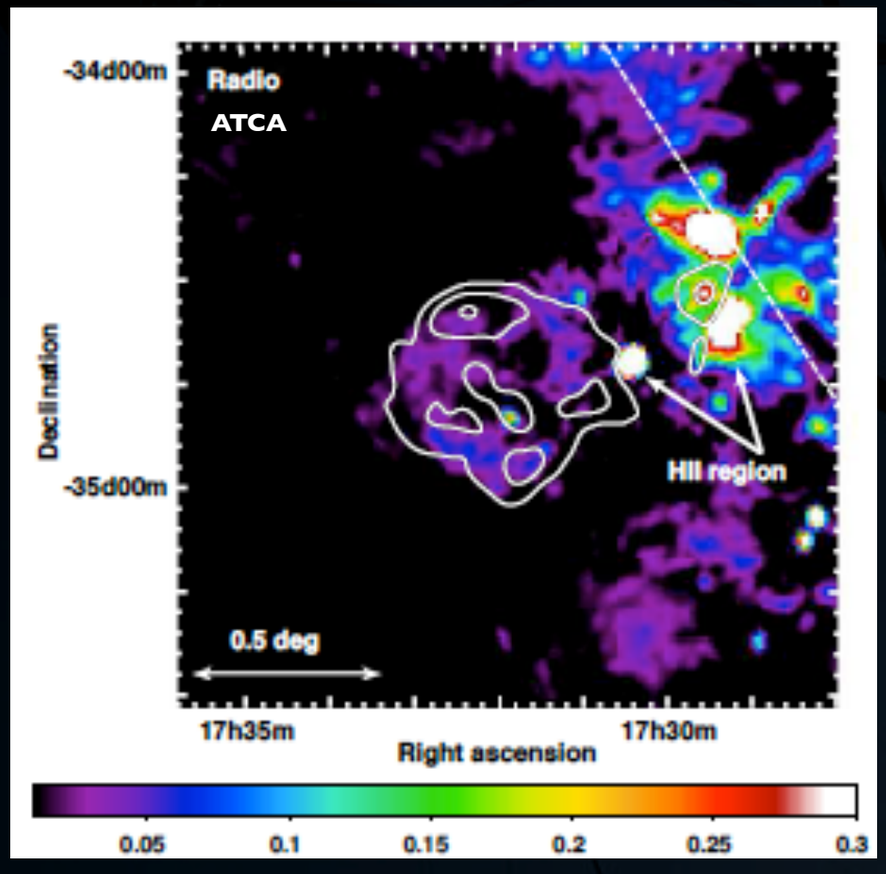




Source Type: Shell-Type Supernova Remnants

- 7(8) shell-type SNRs detected at TeV energies
- Up to ~3 kpc away
- BUT large FoV and deep surveys allow the serendipitous discovery of new SNRs i.e. SNR G353.6-0.7 or HESS J1912+101 (?)

Name	Dist (kpc)	Size (pc)	Age (yrs)	L_γ (10^{33} erg/s)	Γ
RX J1713.7–3946	1	17.4	1.6	8	2.0
RX J0852–4622	0.2(1)	6.8(34)	0.4(5)	0.26(6.4)	2.2
RCW 86	1(2.5)	11(28)	1.6(10)	1(6)	2.5
SN 1006	2.2	18.3	1	1.24	2.3
Cas A	3.4	2.5	350	7	2.4
Tycho	3.5	6	438	0.1	1.95
SNR G353.6-0.7	3.2	27	2.5(14)	10	2.3



HESS Collaboration 2011

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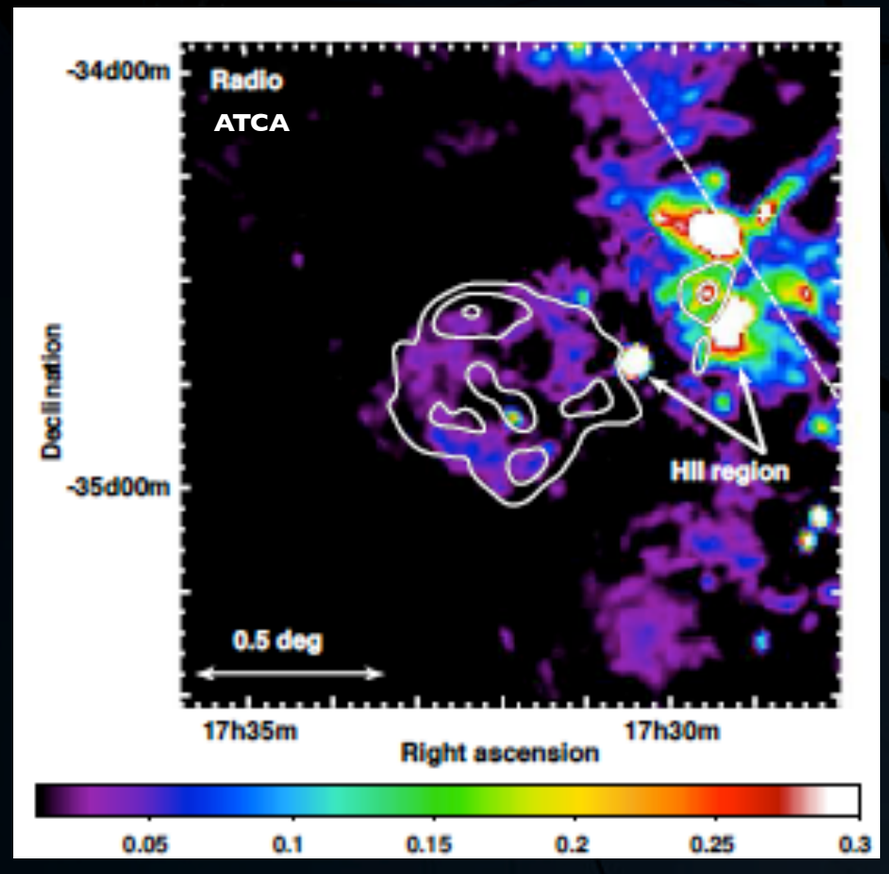
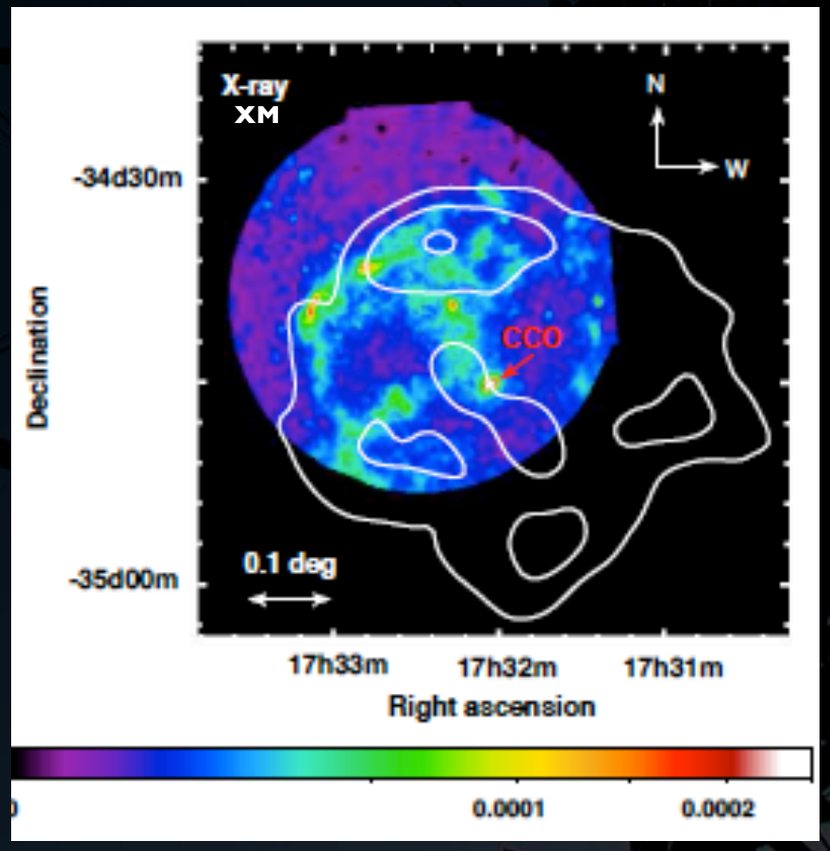
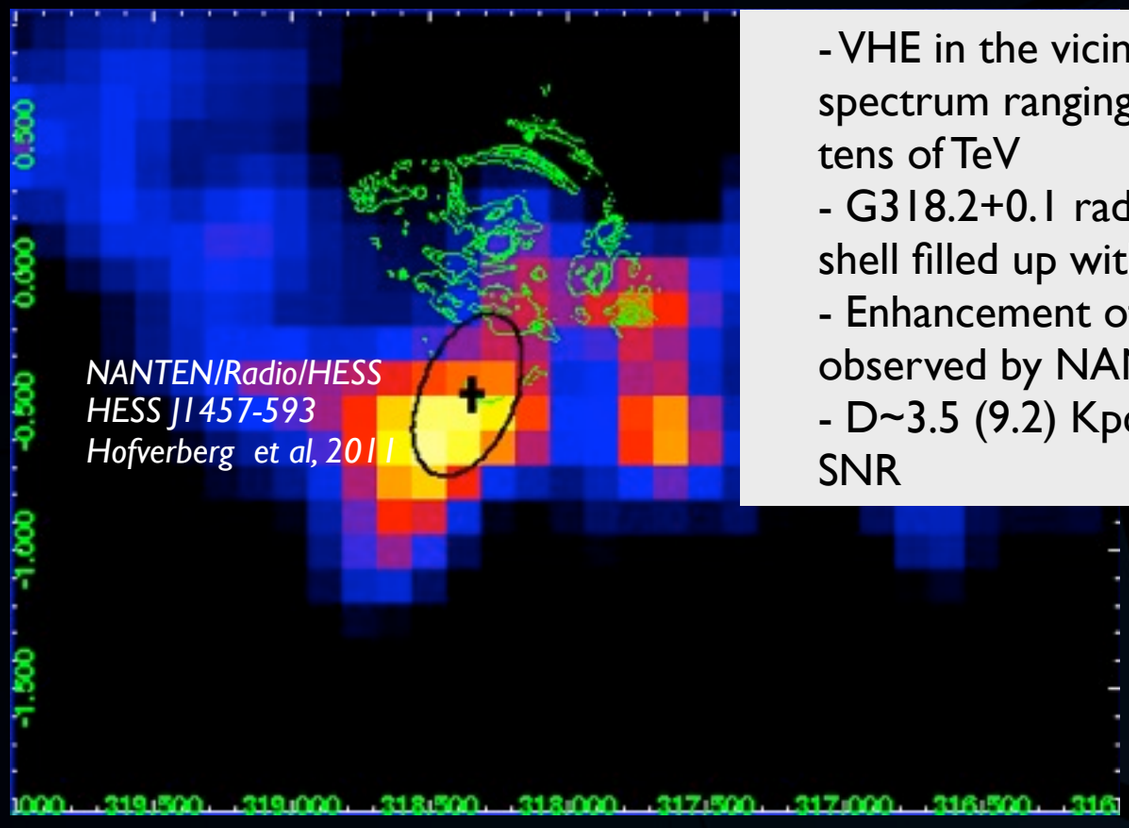




HESS Collaboration 2011

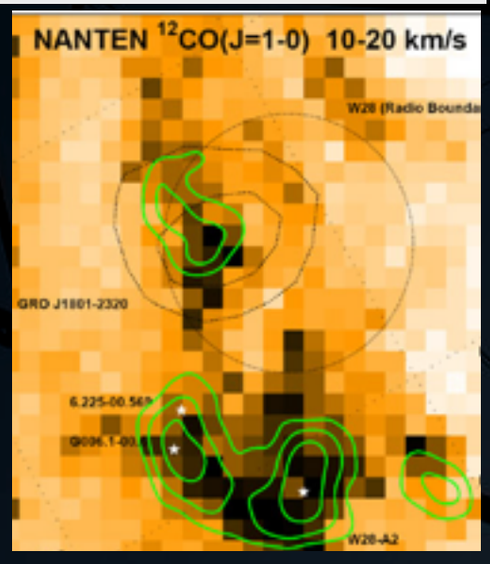
Source Type: Supernova Remnants in dense environment

- Large number of SNRs interacting with Molecular Clouds detected at lower energies by Fermi
- Detection of the tail of the LAT gamma-ray spectrum

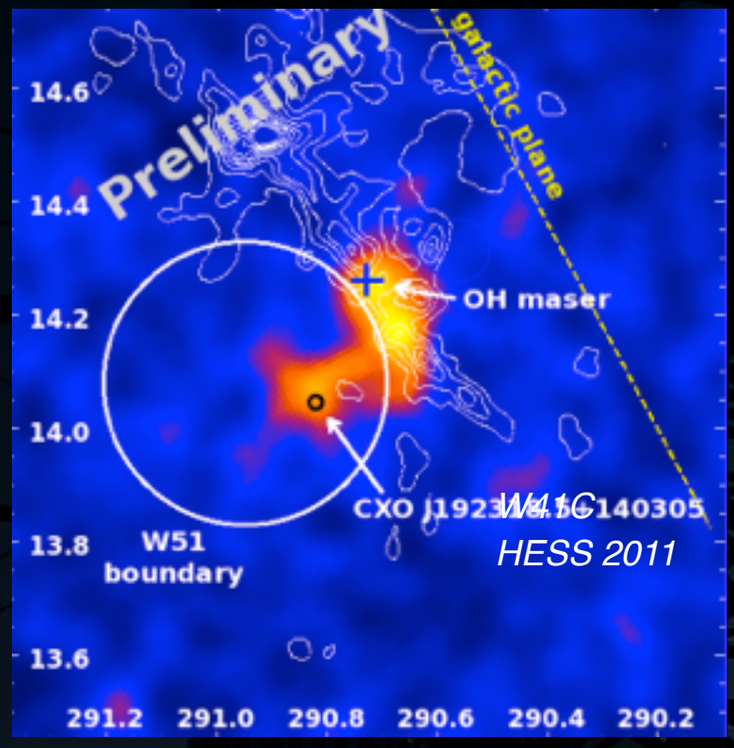


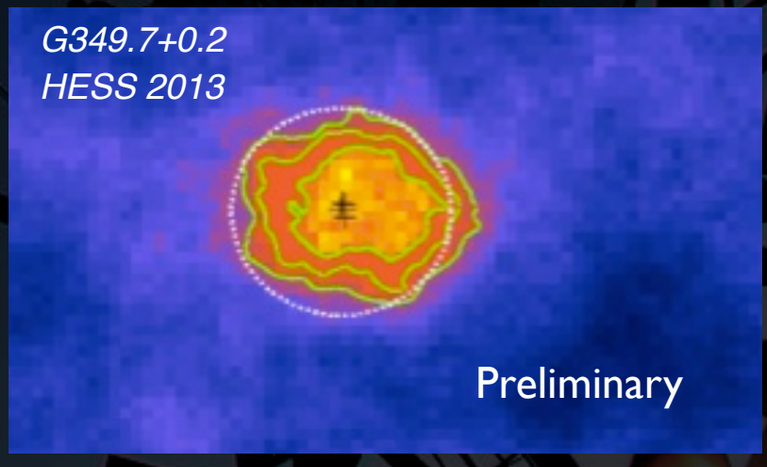
NANTEN/Radio/HESS
HESS J1457-593
Hofverberg et al, 2011

- VHE in the vicinity of G318.2+0.1 with a flat spectrum ranging from a few 100 MeV to few tens of TeV
- G318.2+0.1 radio bright North and South shell filled up with thermal emission
- Enhancement of Molecular Content observed by NANTEN and with Fermi LAT
- D~3.5 (9.2) Kpc -> 50 pc if related to the SNR



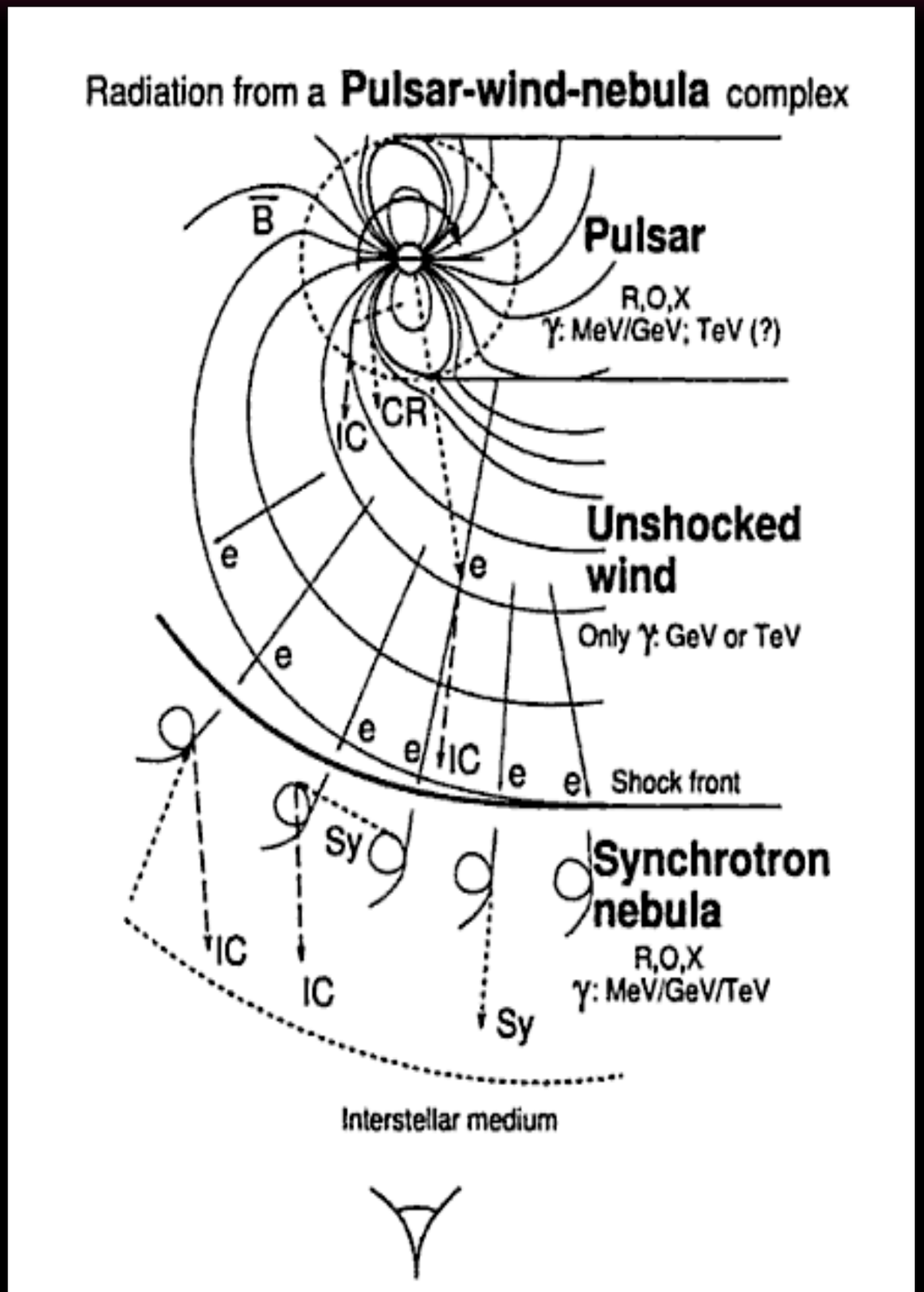
W28
Aharonian et al, 2007





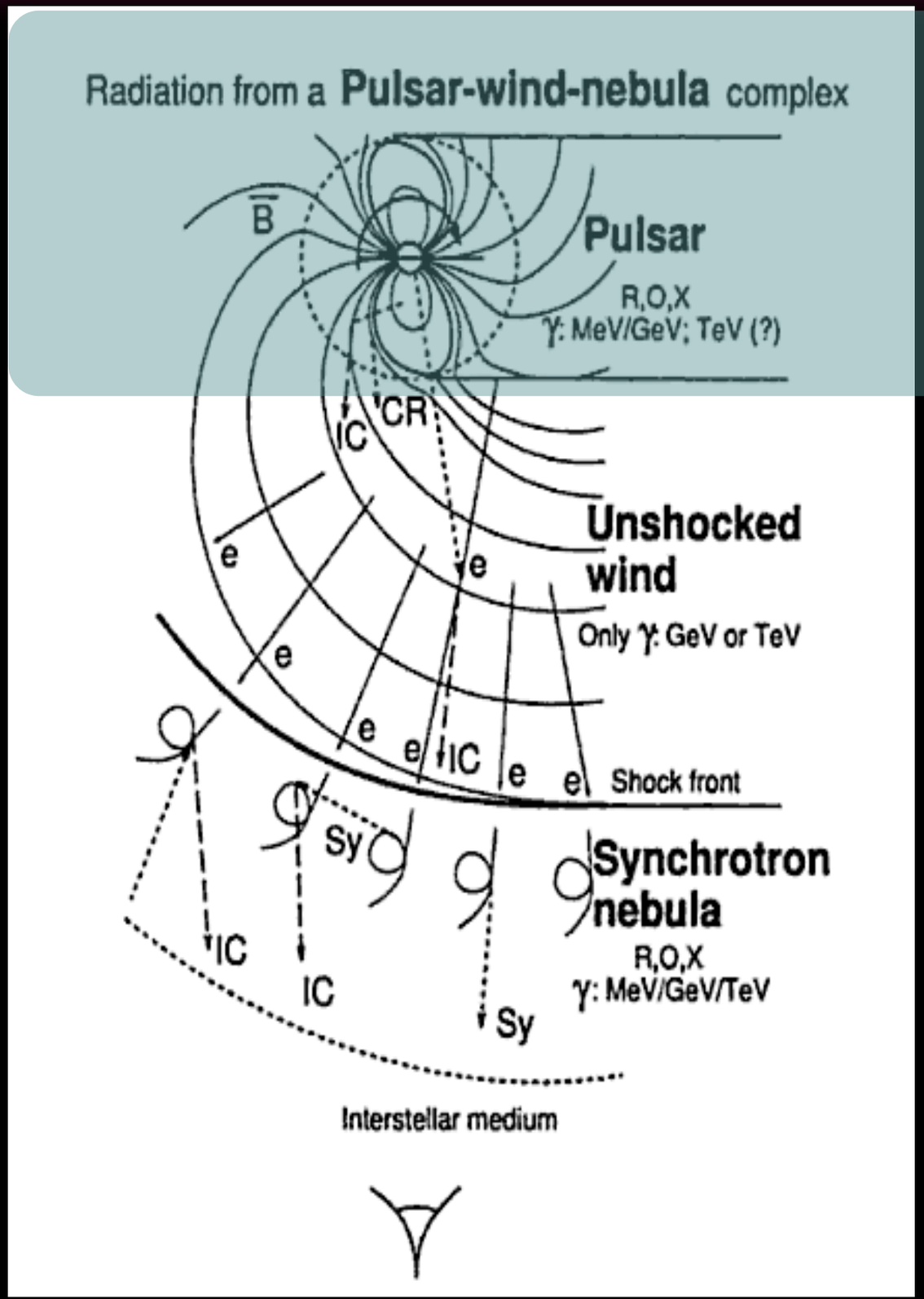
- G349.7+0.2, 0.4% Crab : d=22 Kpc! interacting with 1e4 Mo cloud (L~2e33 erg/s)
- W51, 3% Crab: d=5.5 kpc interacting with 2e5 Mo cloud (L~1e36 erg/s)

Source Type: Pulsars and their relativistic Winds



Aharonian 2008

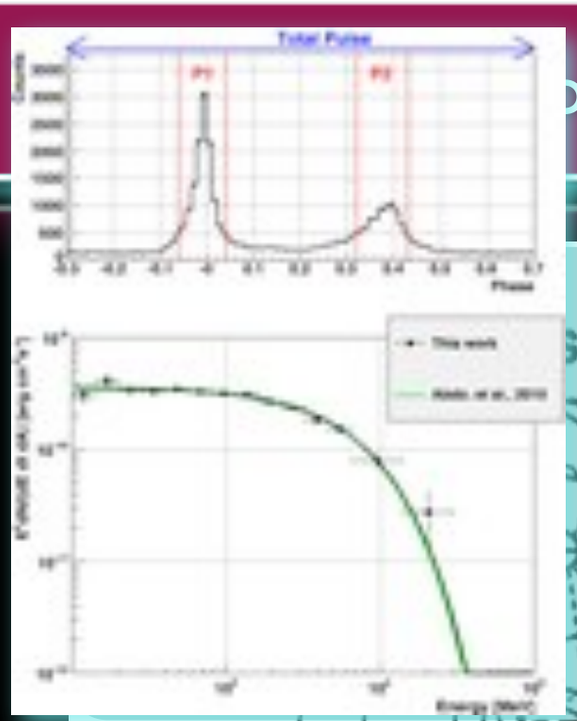
Source Type: Pulsars and their relativistic Winds



- Pulsed emission
  - Polar cap/Outer gap
  - Slot gap
  - Striped wind model
  - Cascading of secondary particles

Aharonian 2008

ource Type: Pulsars and their relativistic Winds



- Pulsed emission
  - Polar cap/Outer gap
  - Slot gap
  - Striped wind model
  - Cascading of secondary particles

Aharonian 2008

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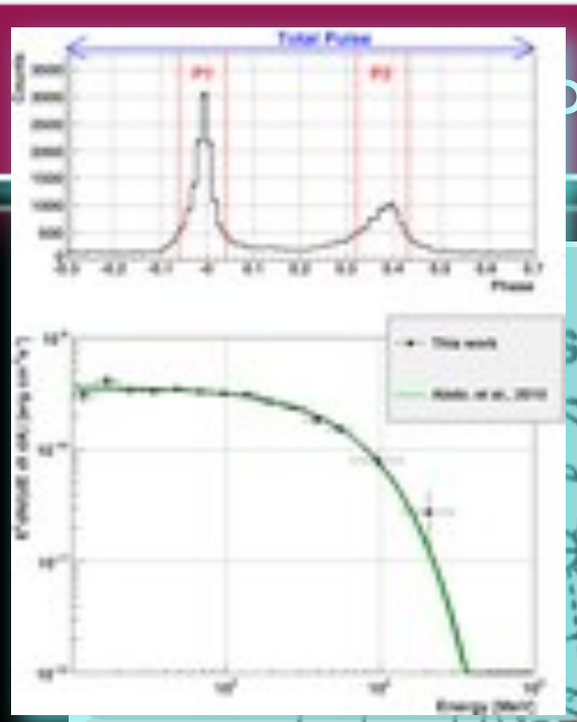

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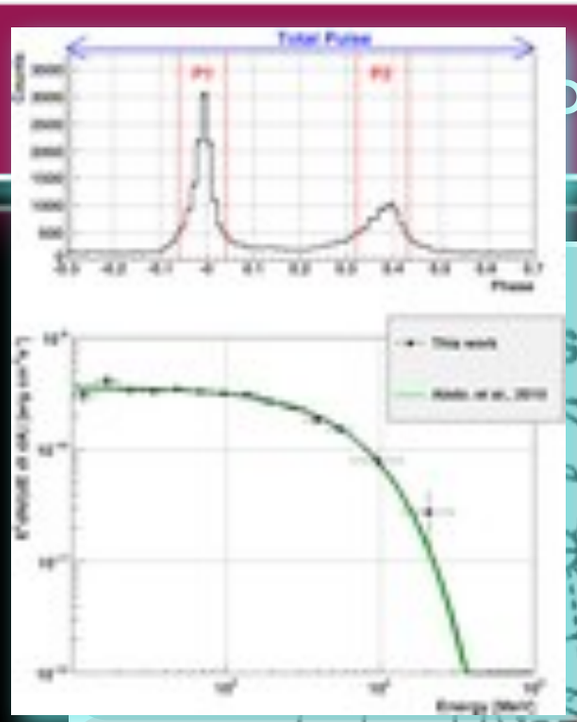

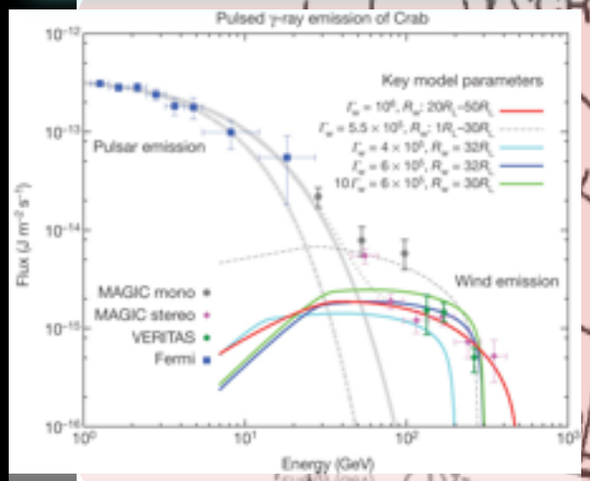

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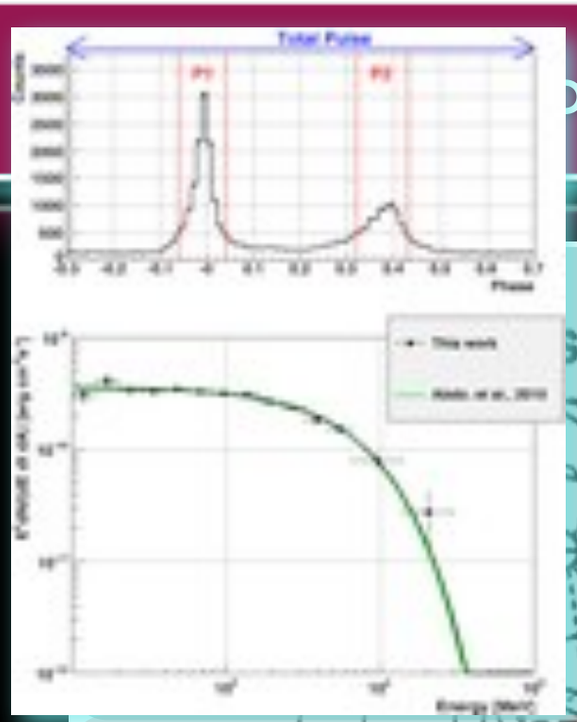

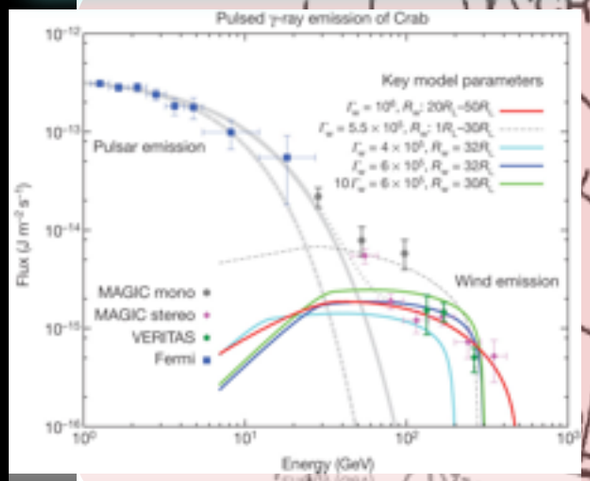

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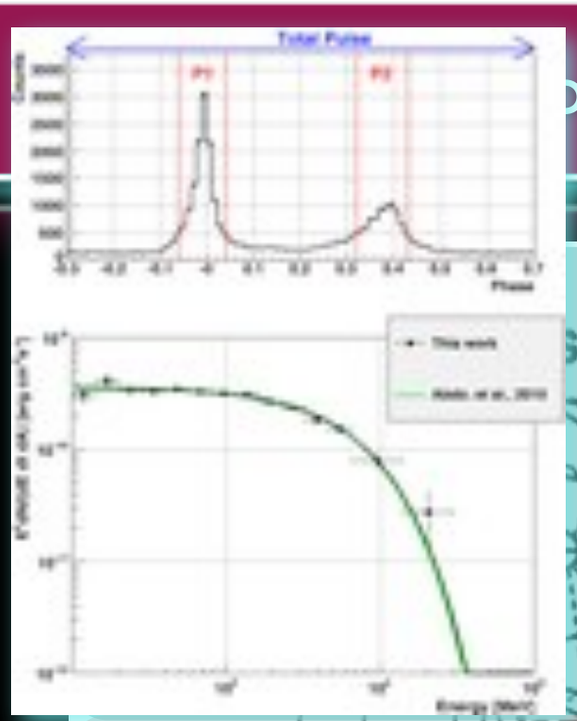

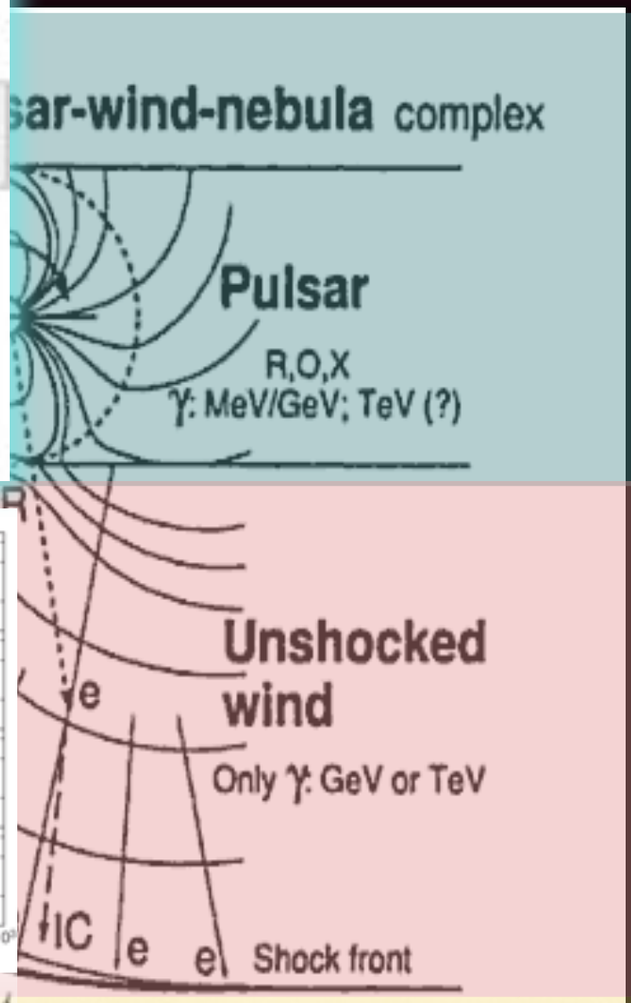

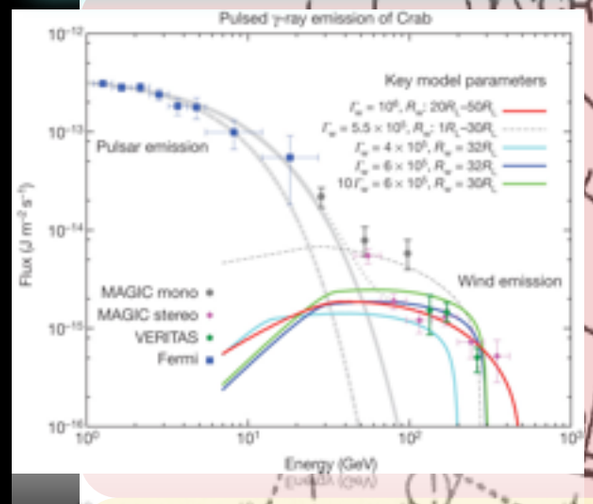

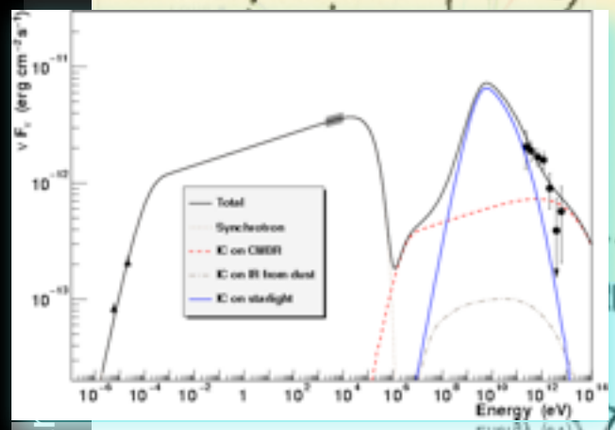

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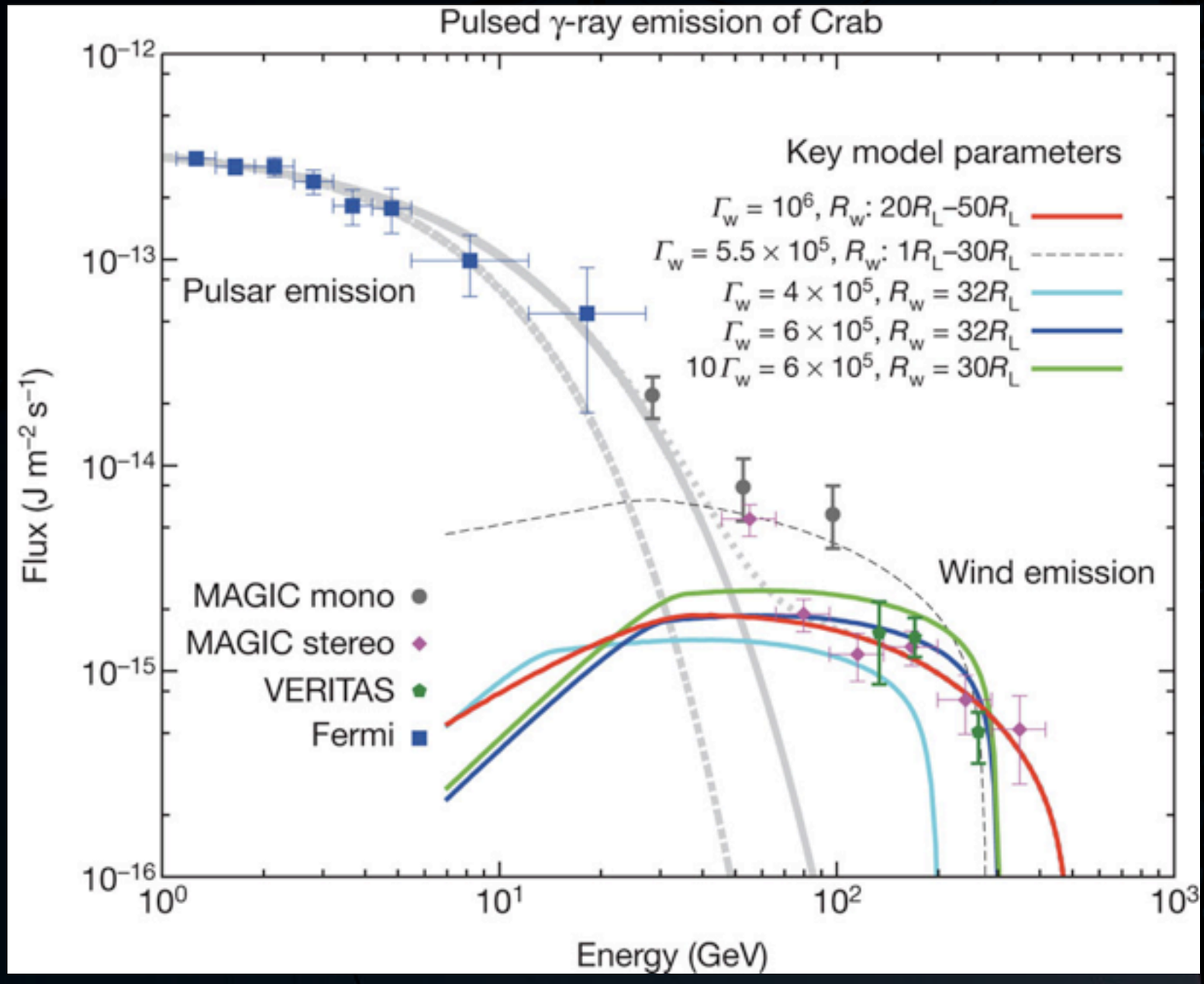
Pulsed emission at VHE

- Two explanation proposed:
  - SSC from secundary electron-positron pairs created in the magnetosphere
  - IC of the relativist wind with pulsed low-energy (X-ray) emission

Hirotani, 2012

Aharonian, 2012



Aharonian et al. *Nature* **482**, 507–509, 2012

Veritas & MAGIC Collaborations, 2011

Source Type: PWNe

- Largest population (>20 identified PWNe)
- young: age<10^5 yrs
  energetic: Edot >10^{35} erg/s

- Populations Studies
  I. Old systems in which we observe leptonic cooling
  II. Young systems showing very good correlations with X-ray and radio

Required Ee to radiate synchrotron keV photons:
E_e = (70 TeV) $B^{-1/2}_{-5}$ $E^{1/2}_{keV}$
Mean Ee to IC scatter CMB to TeV photons:
E_e = (18 TeV) $E^{1/2}_{TeV}$
(E_{keV}=0.06 $B_{-5}E_{TeV}$)

Hofmann 2009

Synchrotron τ, scattering CMB to $E_\gamma=10^{12}$ E_{TeV} eV
$\tau(E_\gamma)$ ~ (4.8 kyr) B^{-2}_{-5} $E_{TeV}^{-1/2}$
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If B~150 uG:
electron producing 1 TeV photons IC will produce 1 keV synchrotron photons
If B<150 uG:
X-ray emitting electrons are more energetic than the gamma-ray emitting ones.

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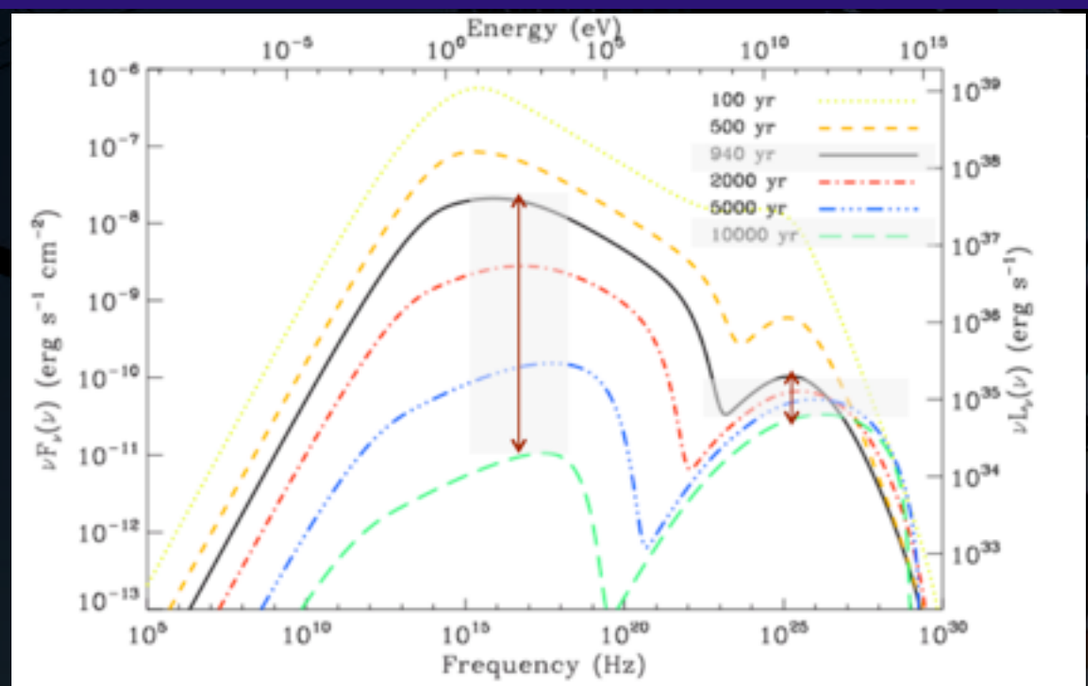

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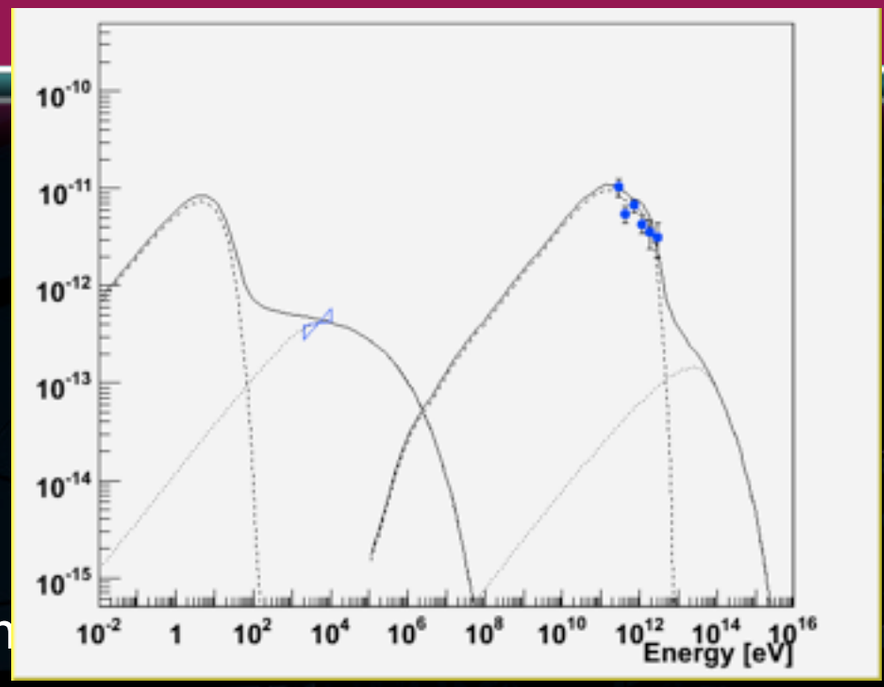

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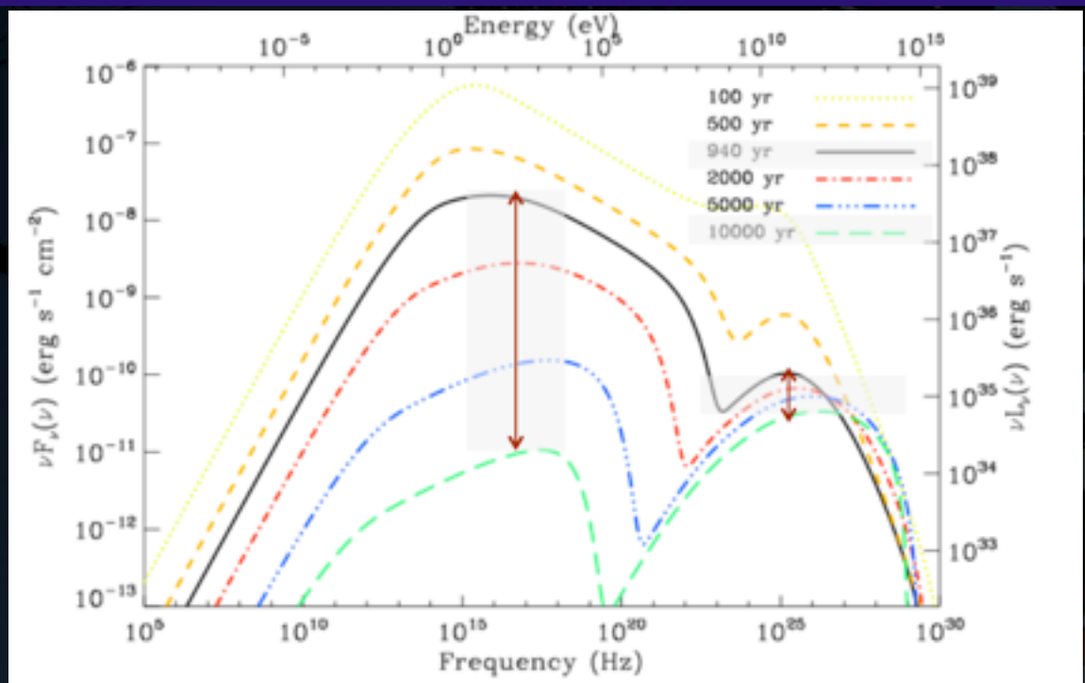

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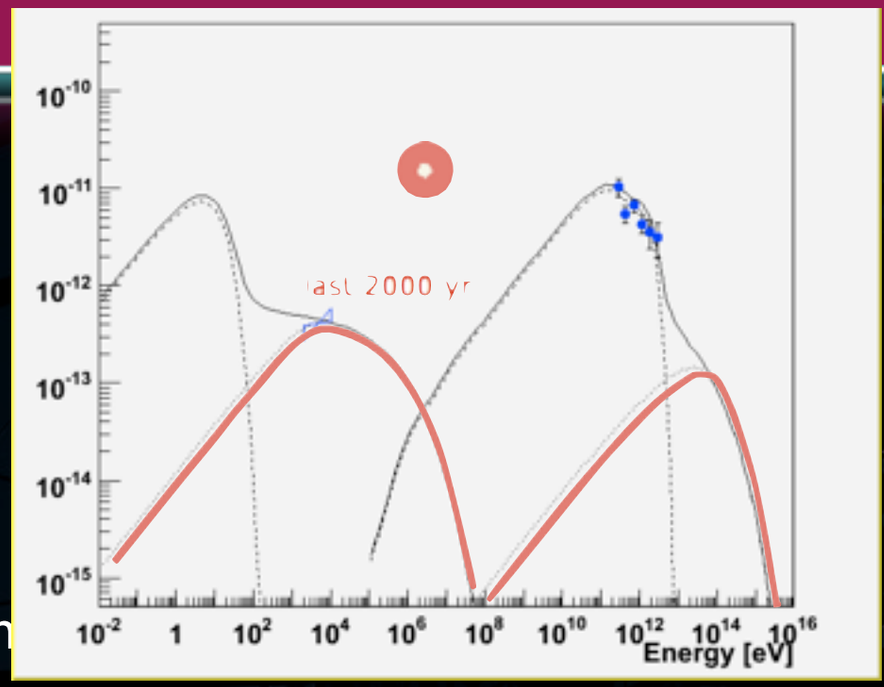

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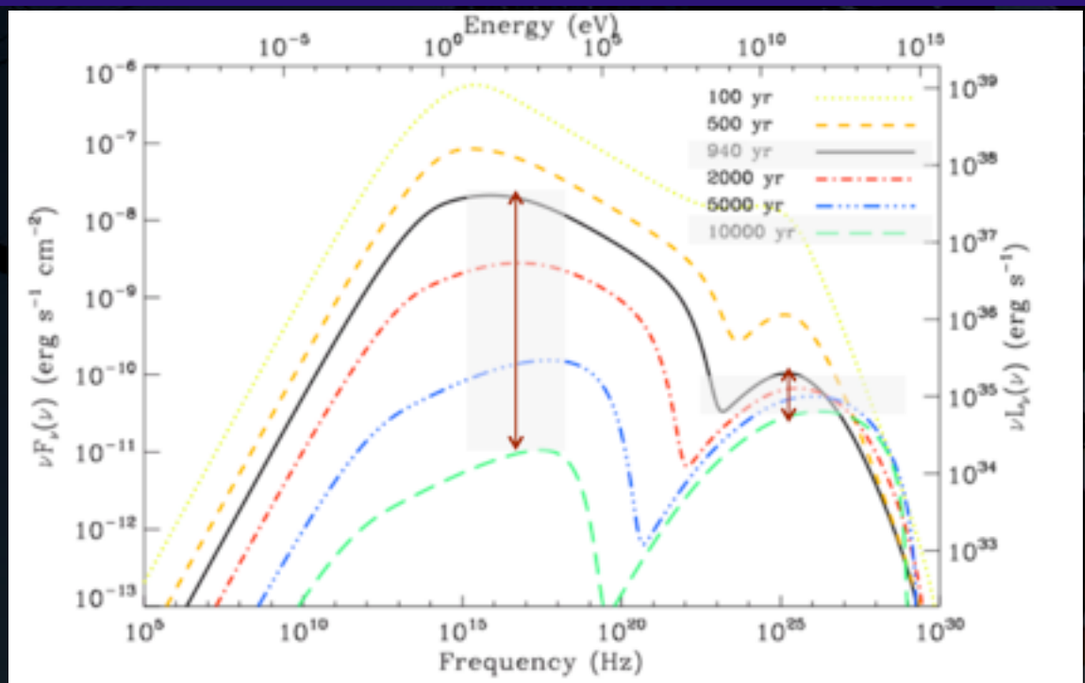

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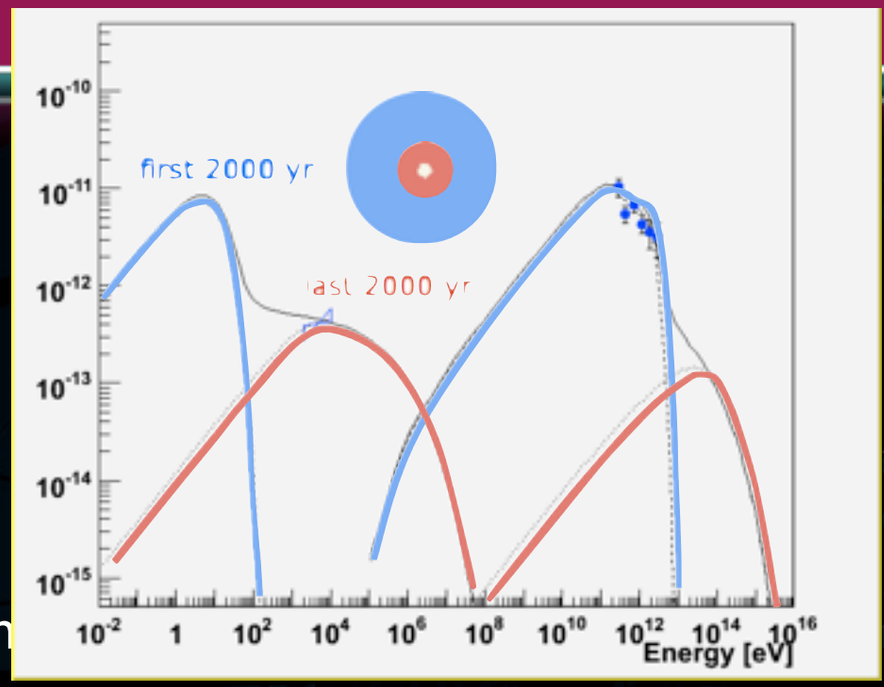

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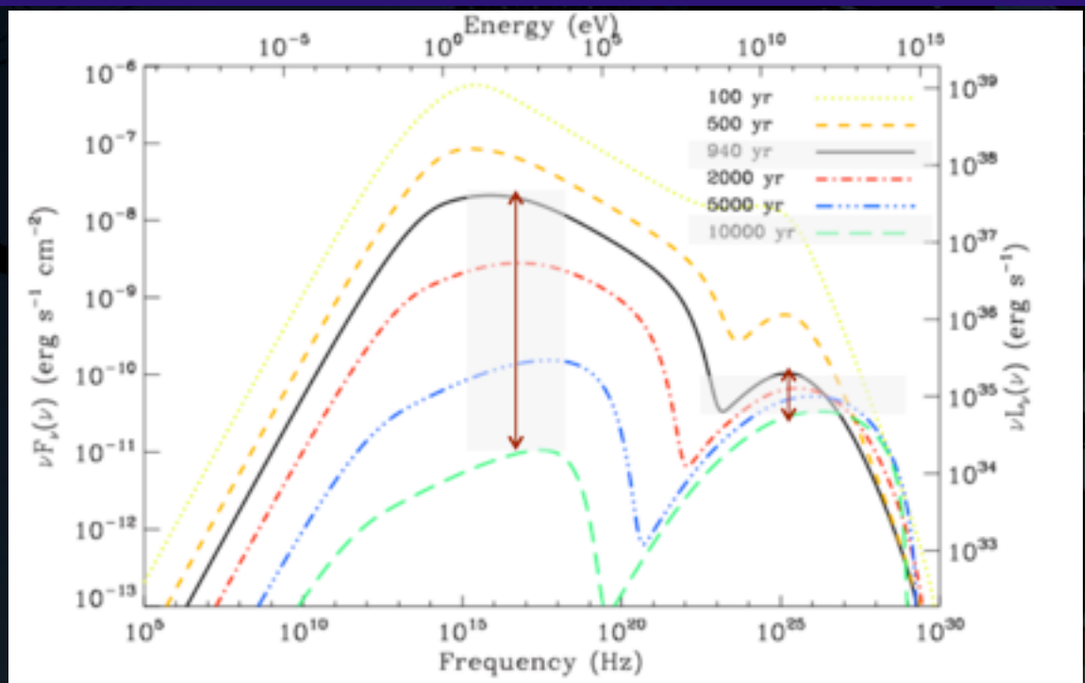

Source Type: "Young" PWNe

Detectable flux/gamma-ray emission depends on:

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- The magnetization fraction η (=σ/(σ+1))
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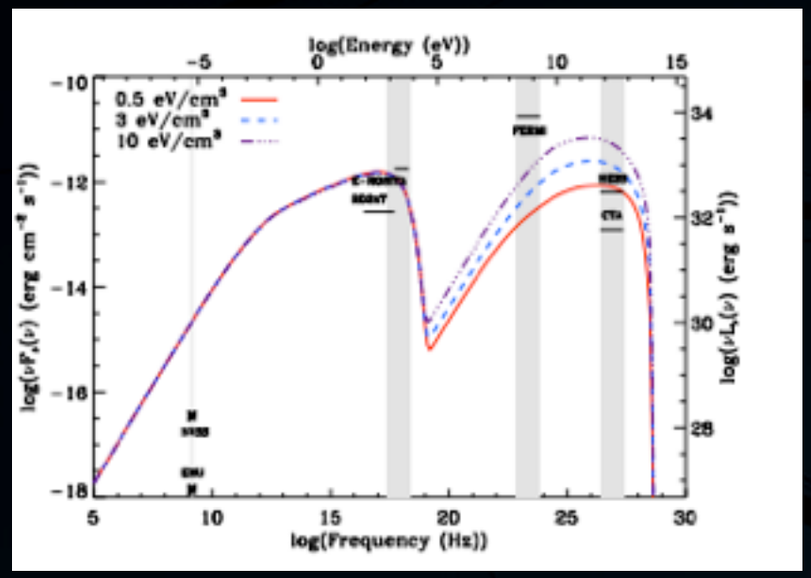
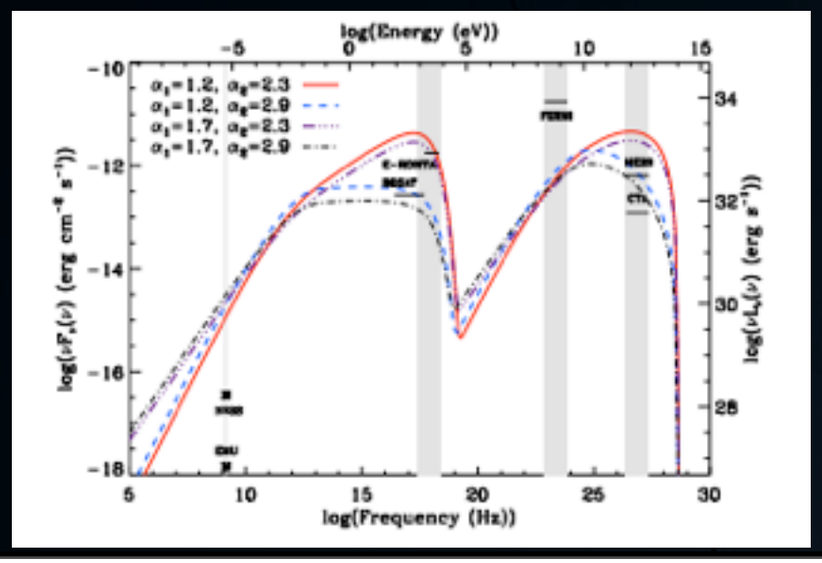
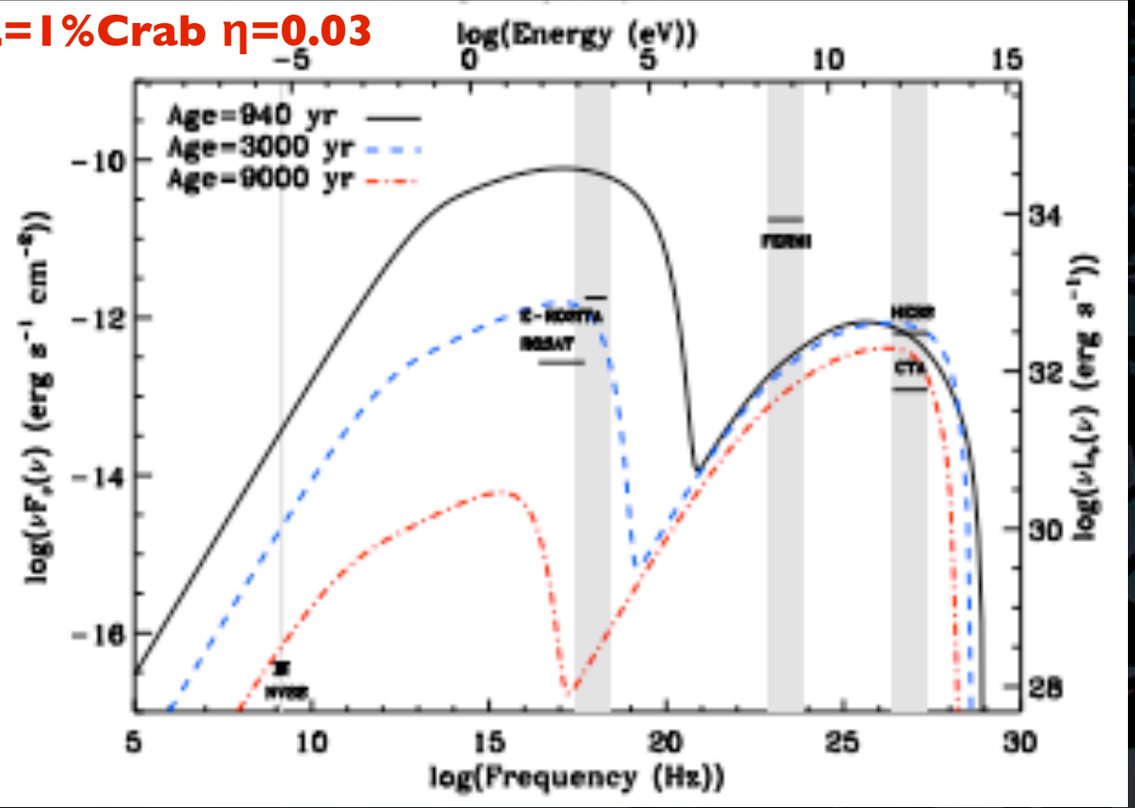


Torres, Martin, dOW et al 2013



L=1%Crab η=0.03



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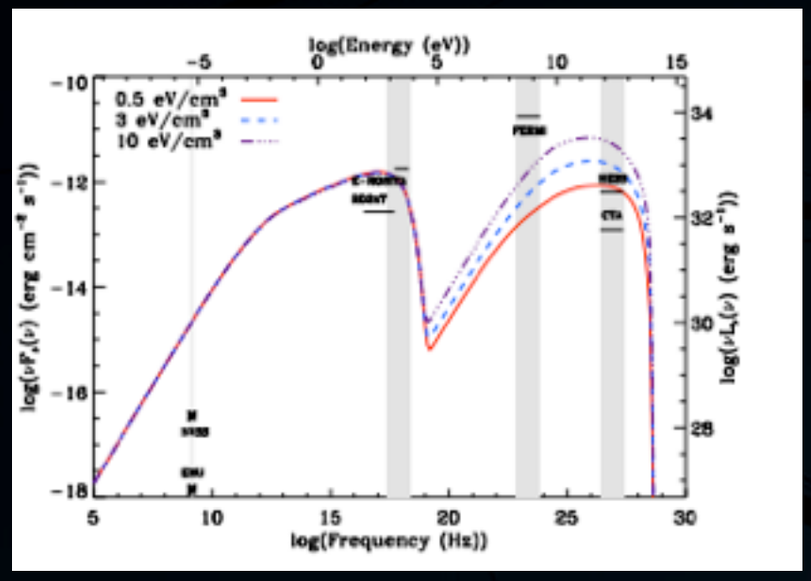

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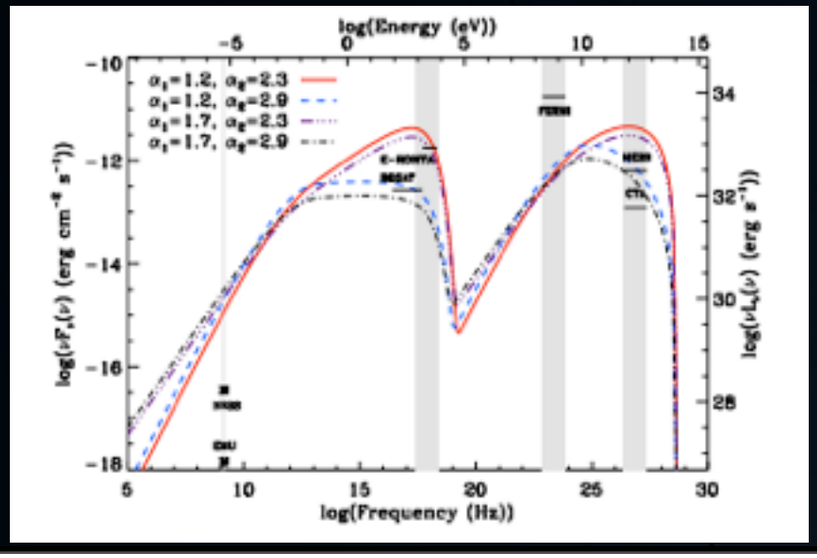
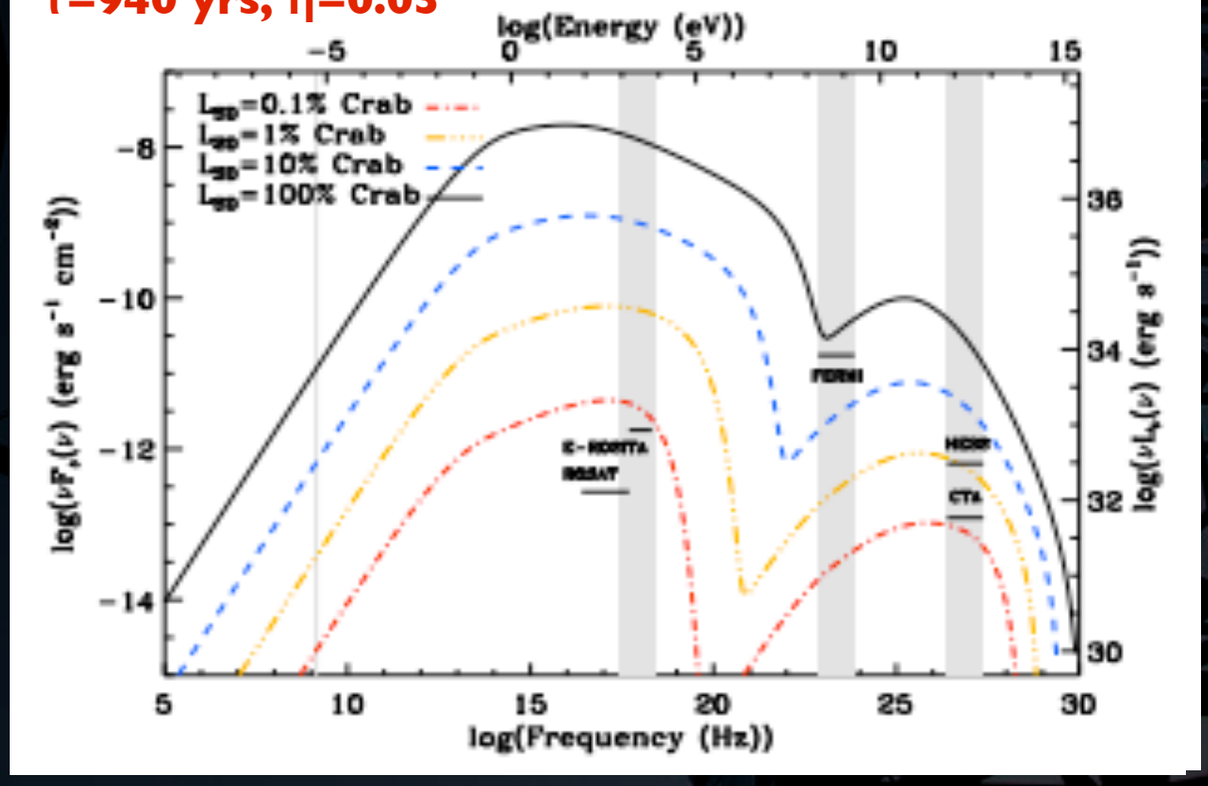


τ=940 yrs, η=0.03



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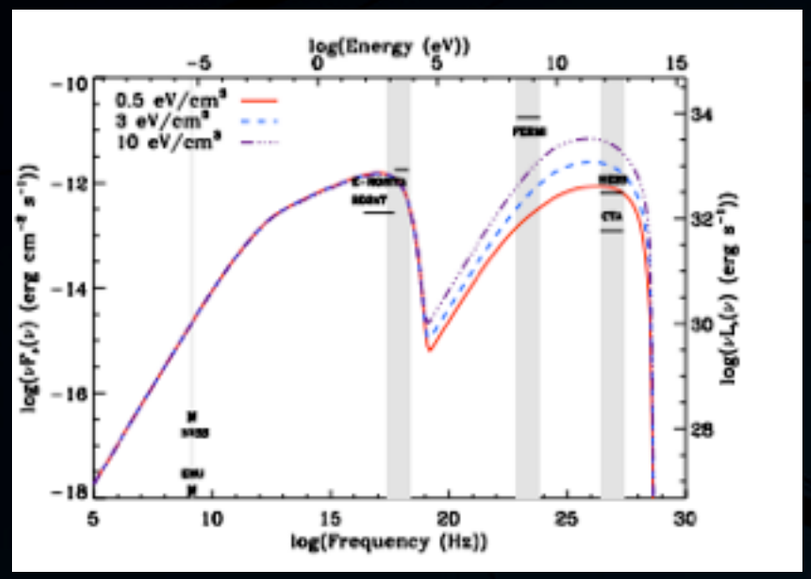

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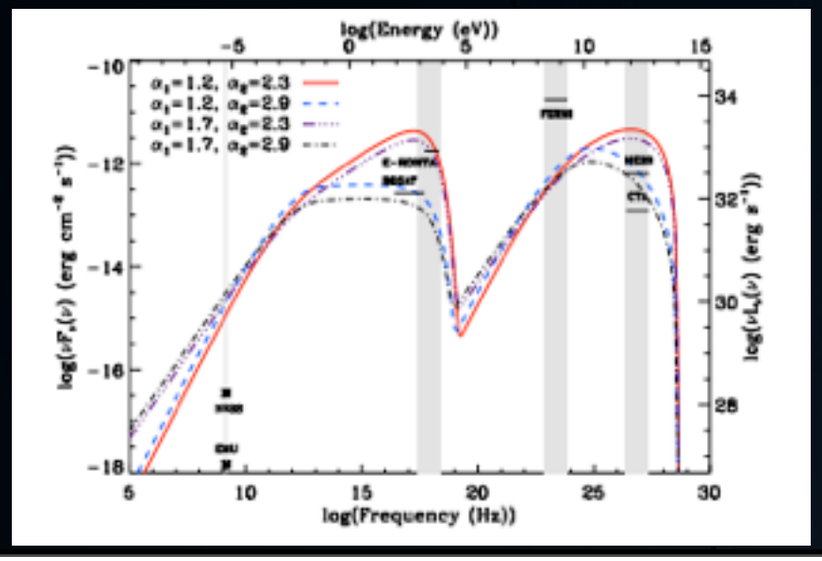
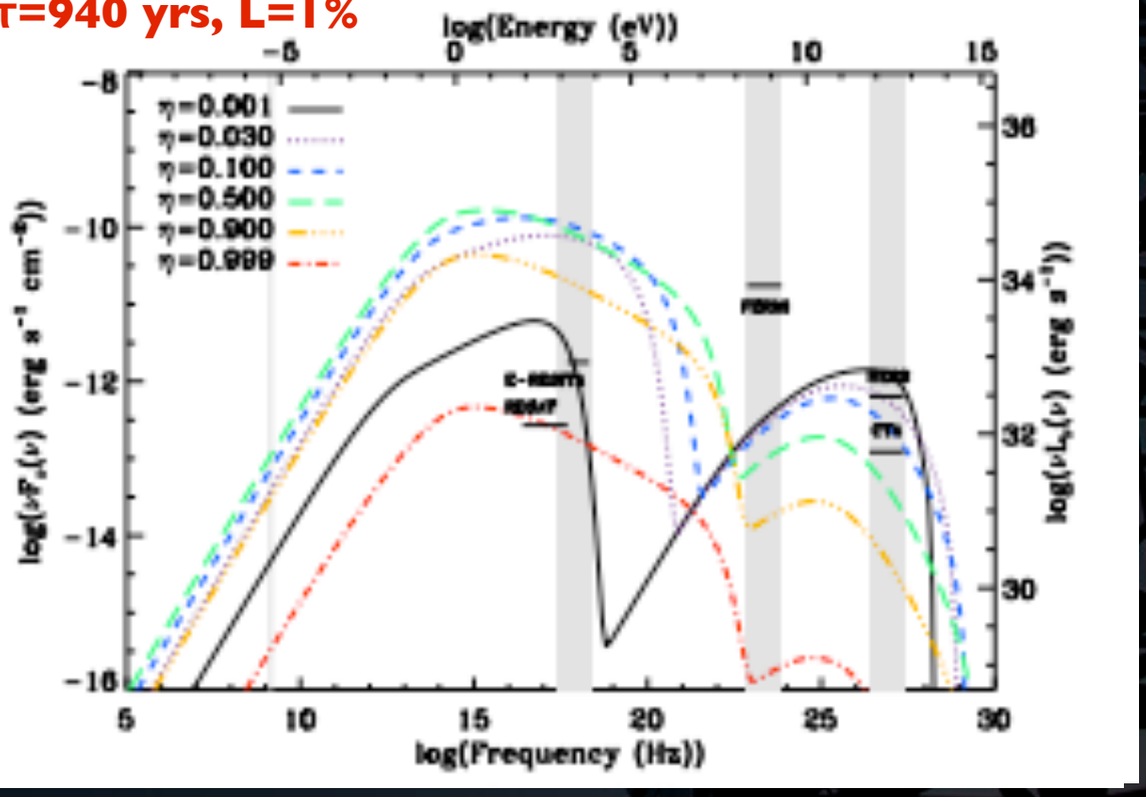


τ=940 yrs, L=1%



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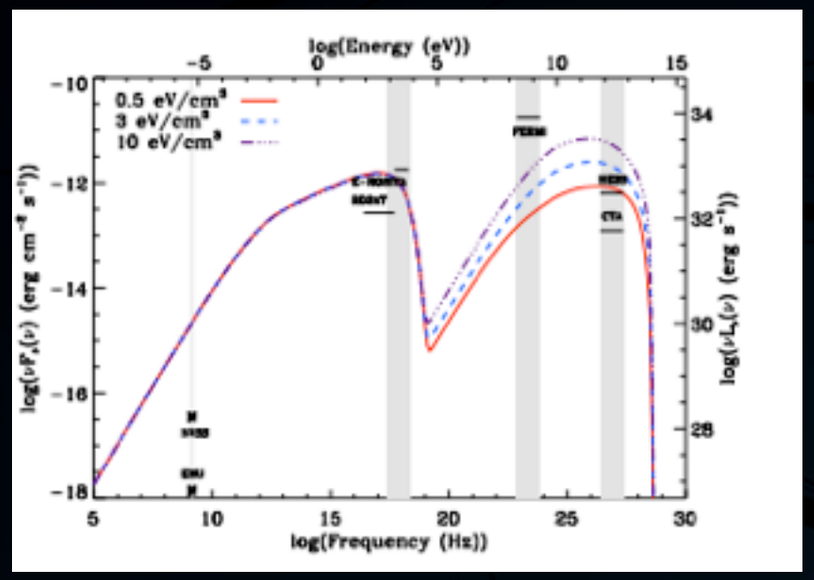

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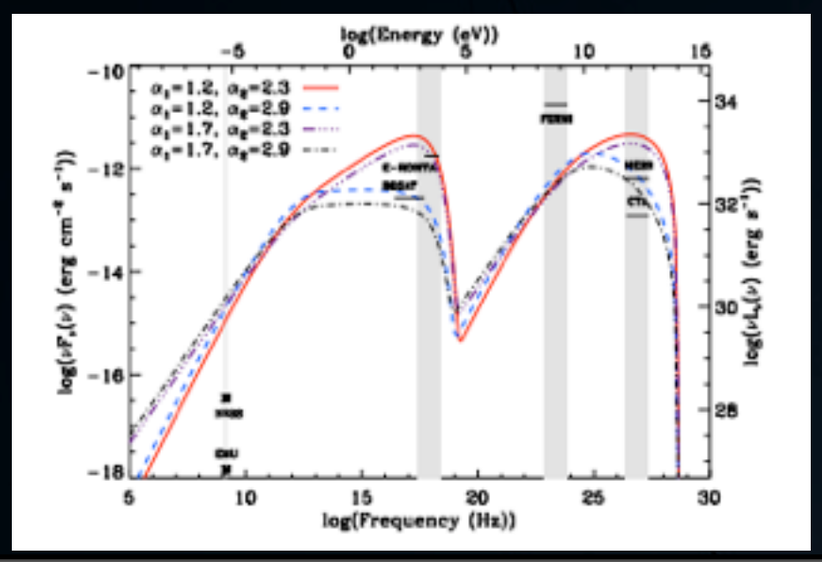
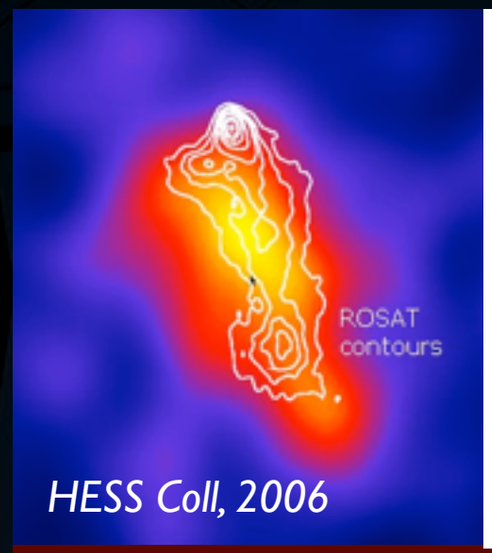
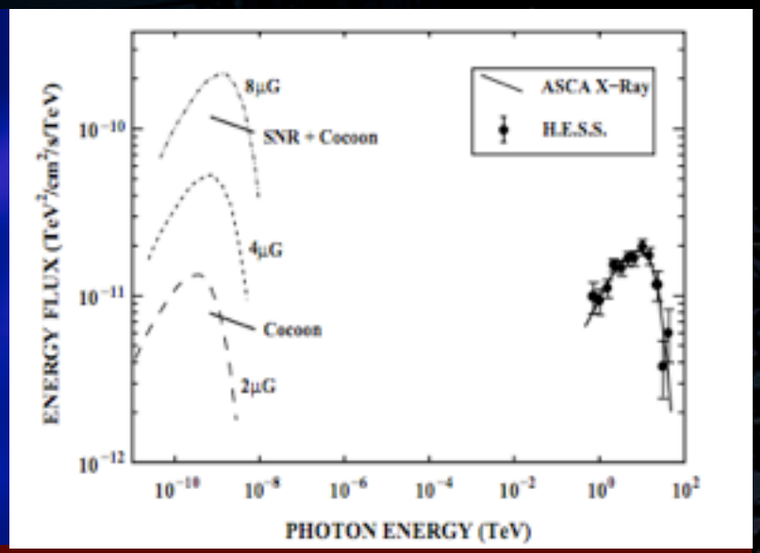




HESS Coll, 2006



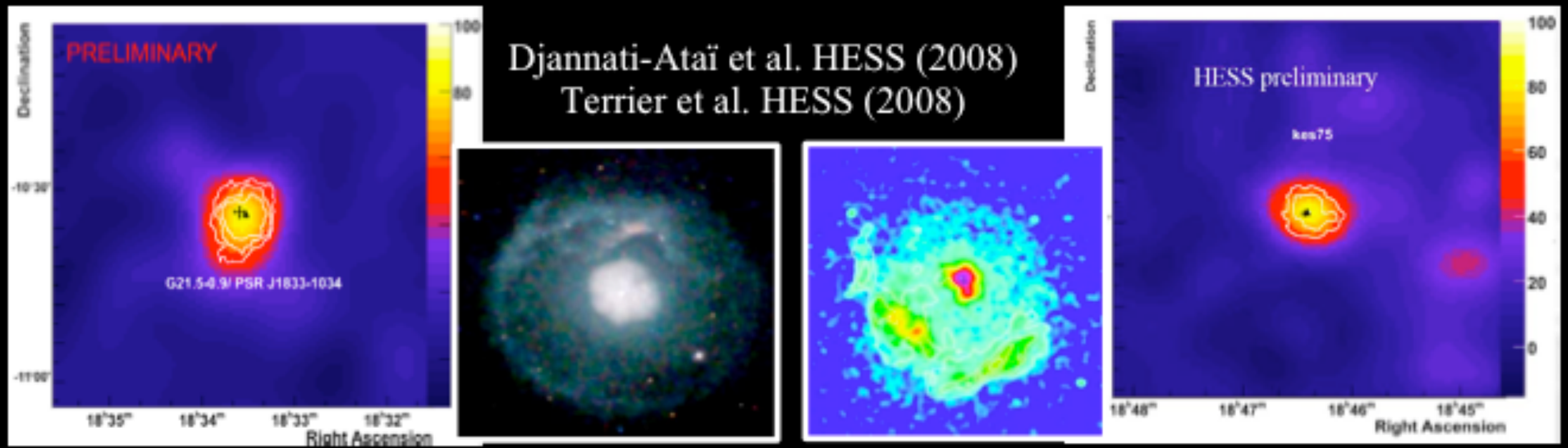
Vela X: d=300 pc
r=0.5-4 pc : very inner part of the PWN
Detection of the peak : determination of B!

Torres, Martin, dOW et al 2013

Source Type: "Young" PWNe

Young PWNe "similar" to the Crab Nebula
Crab has a very large B but also spin-down power!
(G0.9+01, MSH 15-52, G21.5-0.9, Kes 75, ...)

L_{Crab}(1-10 TeV) ~3×10^{34} erg/s
$\dot{E}_{Crab}$ ~ 4.6×10^{38} erg



<u>G21.5/PSR J1833-1034:</u>

τ=4.7 kyr, Edot=33×10^{36} erg/s, d~5kpc

L(1-10 TeV) =$3.7e^{33}$ erg/s

B~25 uG

<u>kes75/PSR J1848-0258:</u>

τ=723 yr, Edot=8.3×10^{36} erg/s, d~6kpc

L(1-10 TeV) =$6e^{33}$ erg/s

B~10 uG

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B far from equipartition: Particle dominated nebulae
Are all TeV PWNe particle dominated?

<u>G21.5/PSR J1833-1034:</u>

τ=4.7 kyr, Edot=33×10^{36} erg/s, d~5kpc

L(1-10 TeV) =$3.7e^{33}$ erg/s

B~25 uG

<u>kes75/PSR J1848-0258:</u>

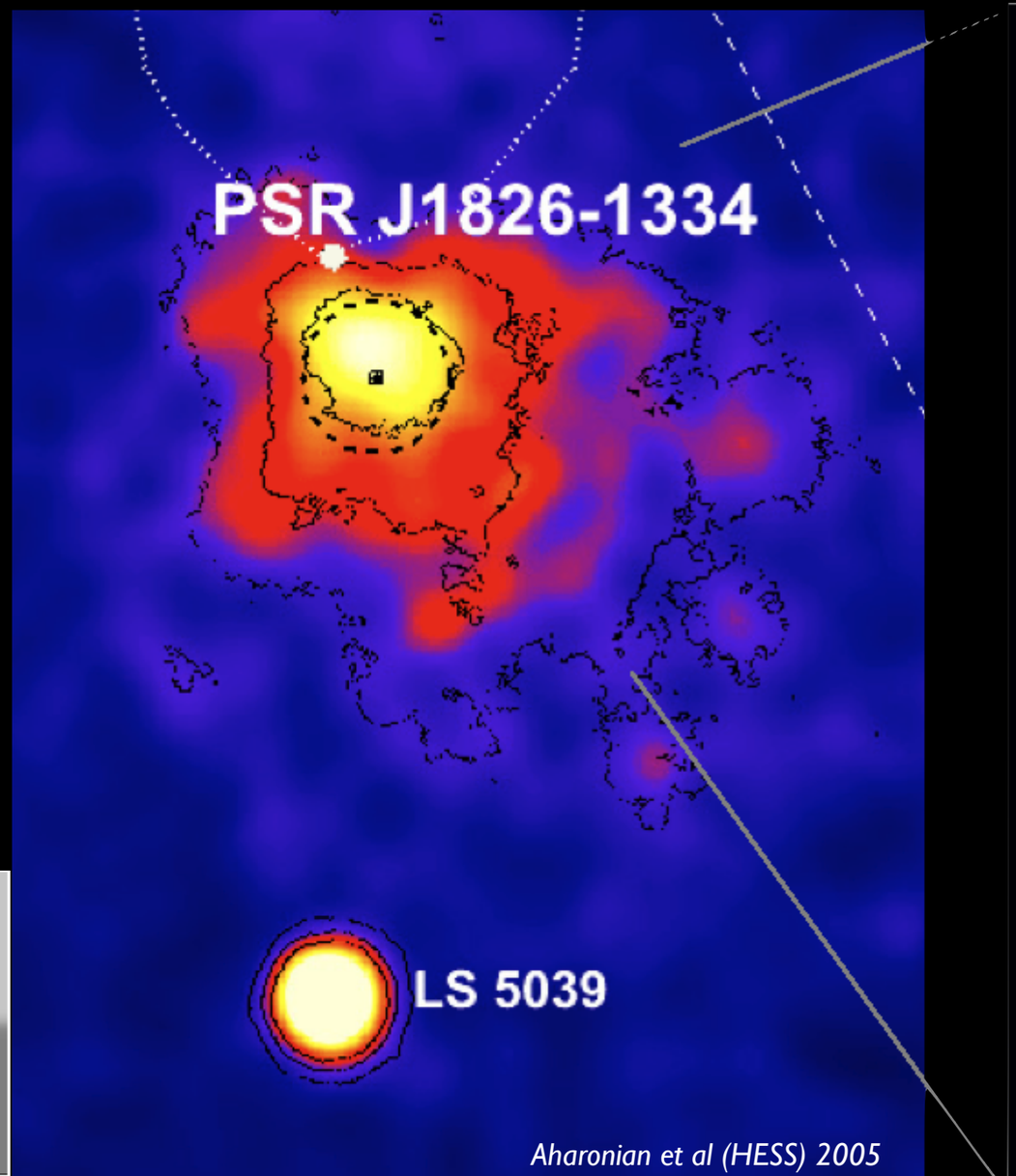
τ=723 yr, Edot=8.3×10^{36} erg/s, d~6kpc

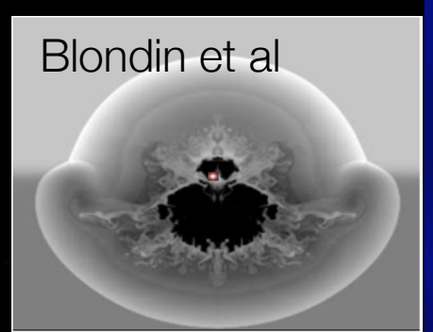
L(1-10 TeV) =$6e^{33}$ erg/s

B~10 uG

Source Type: Relic PWNe

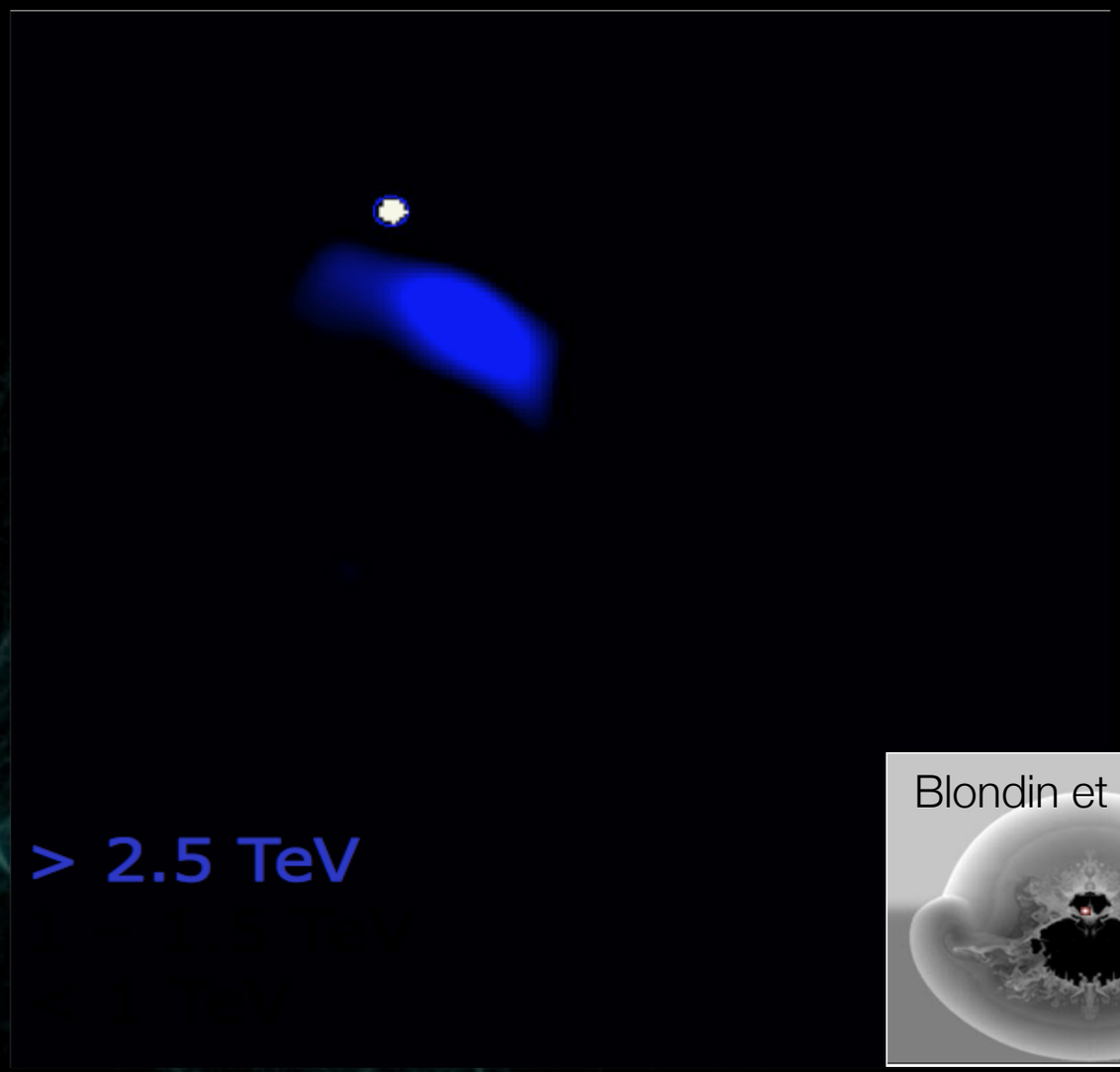
21 kys

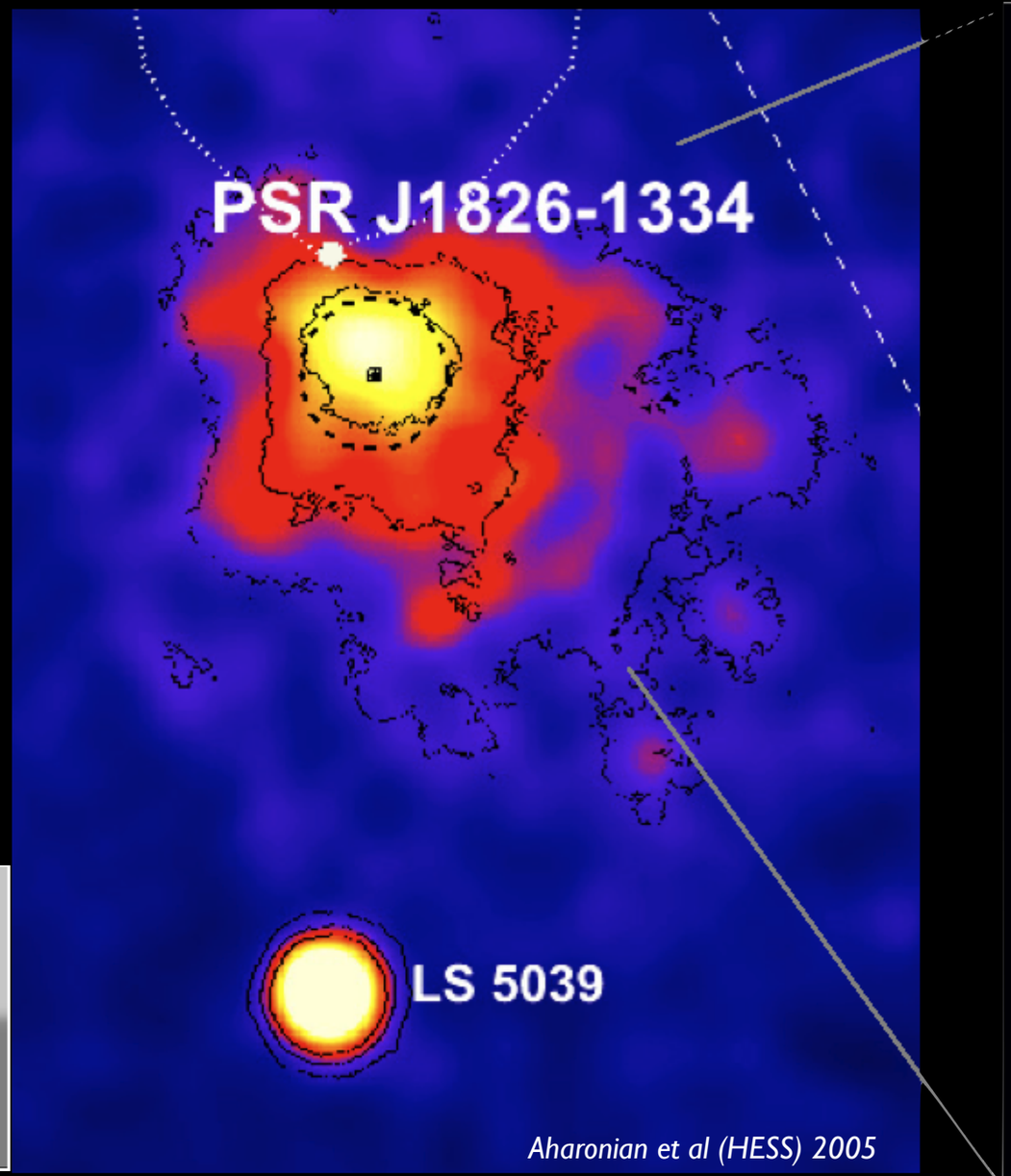




Source Type: Relic PWNe

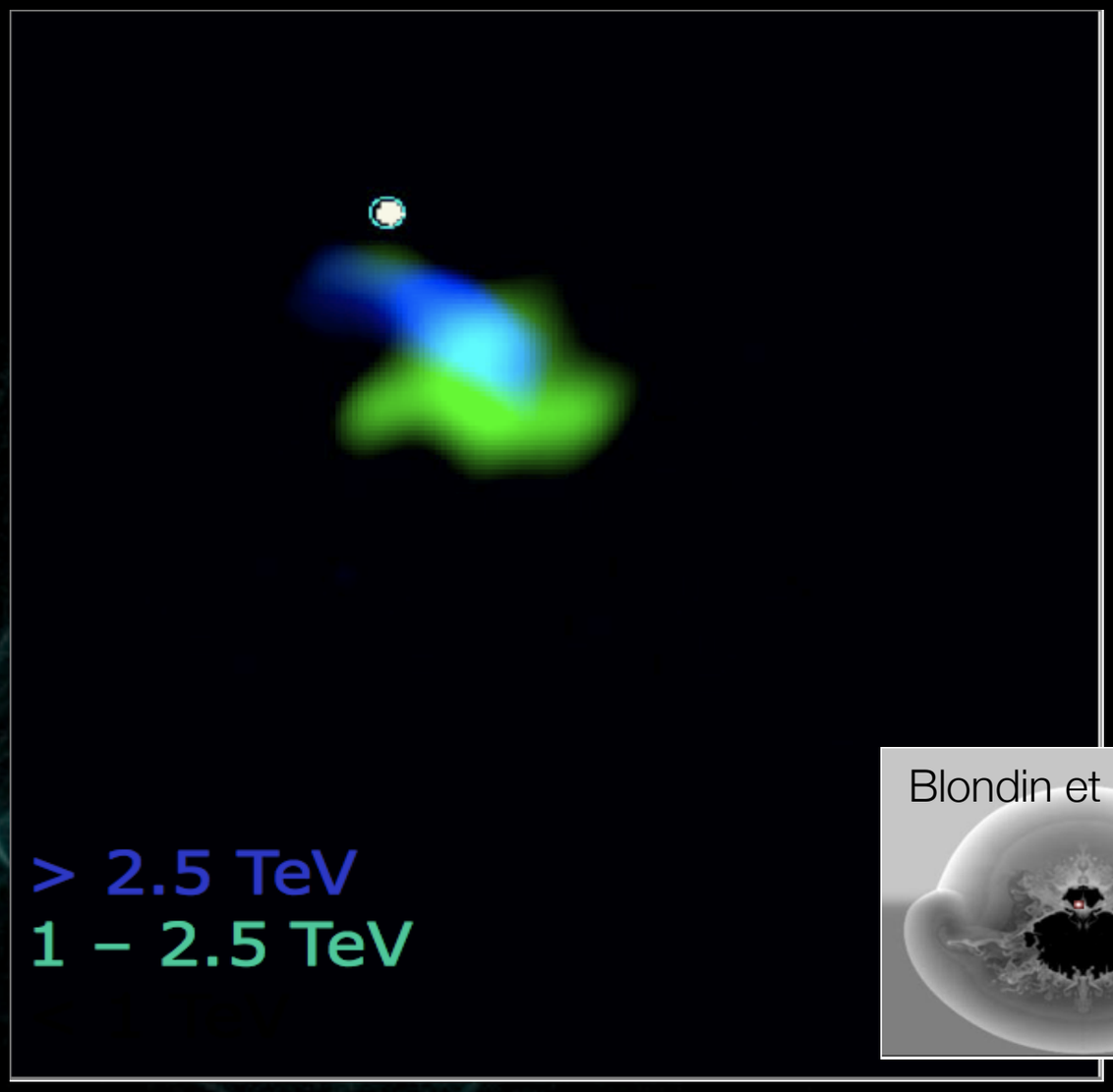
21 kys

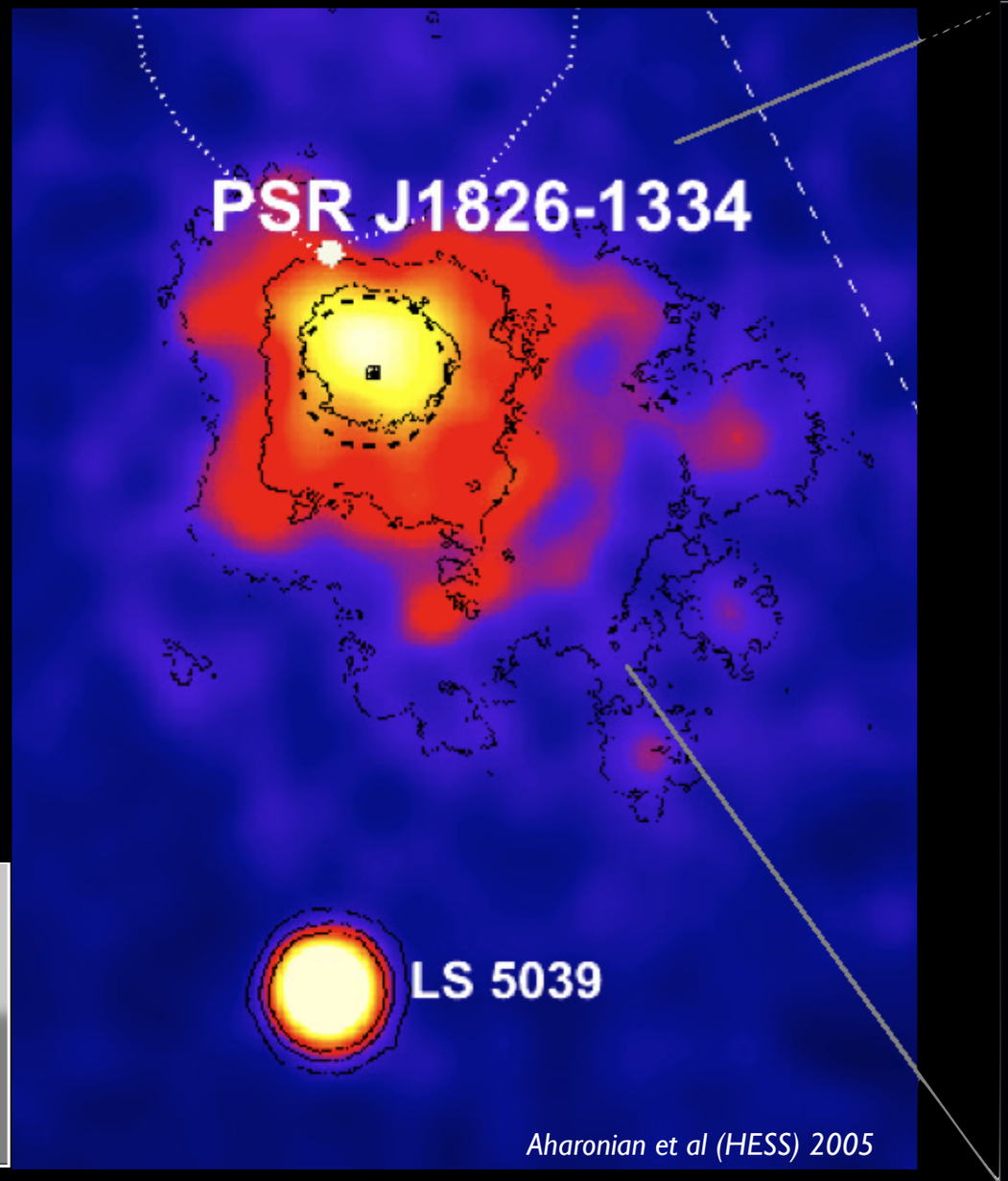




Source Type: Relic PWNe

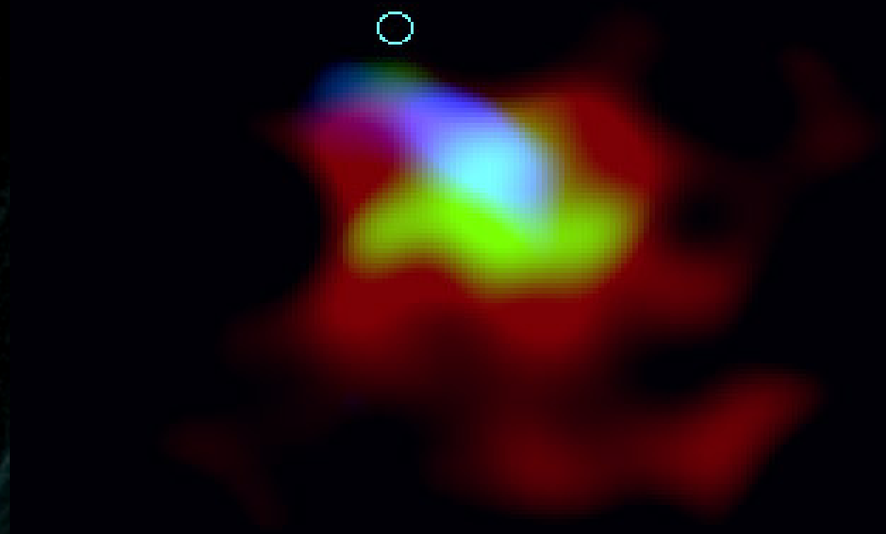
21 kys



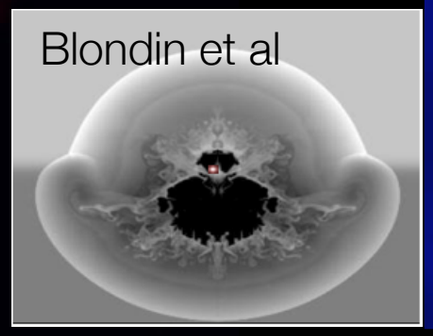


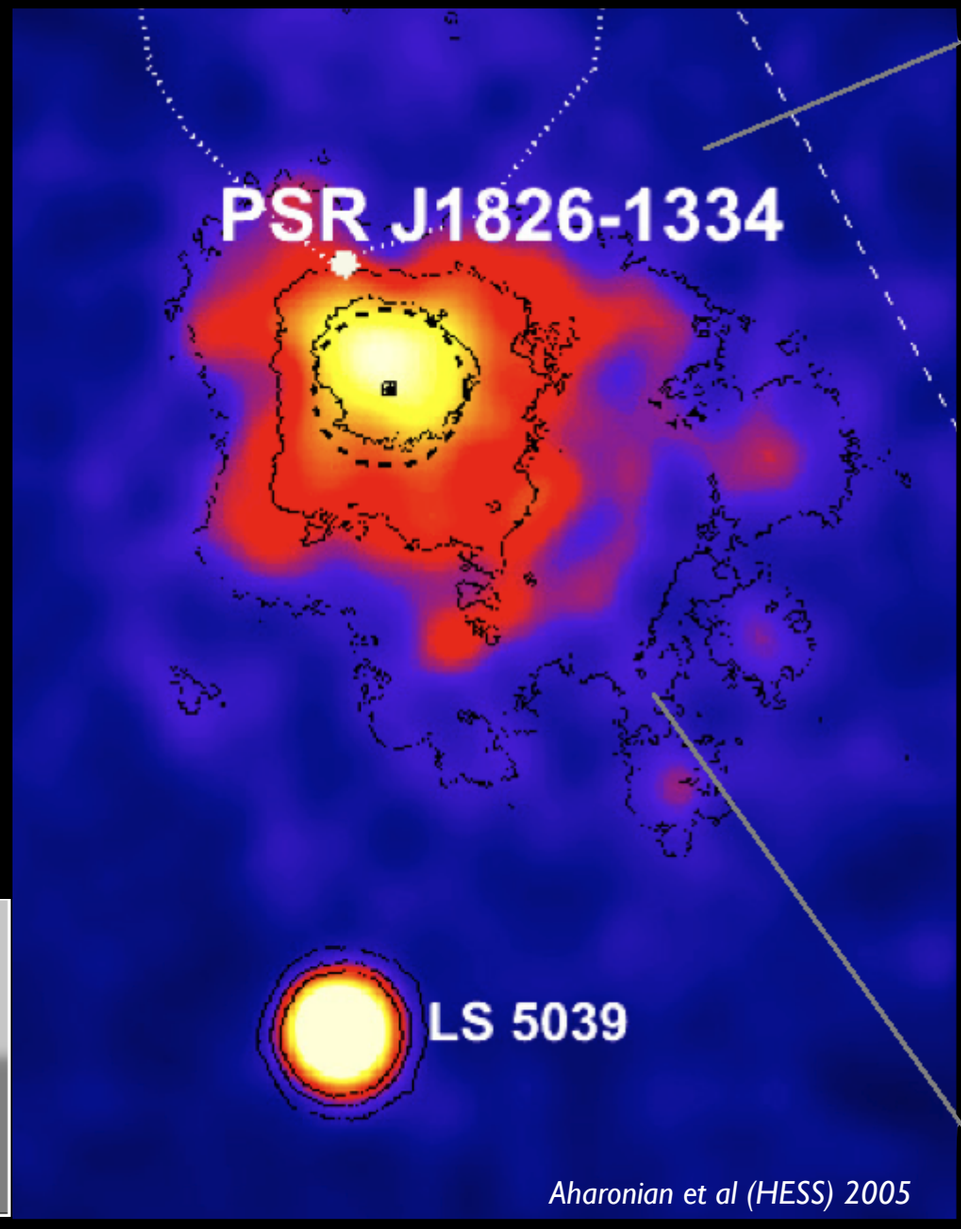
Source Type: Relic PWNe

21 kys



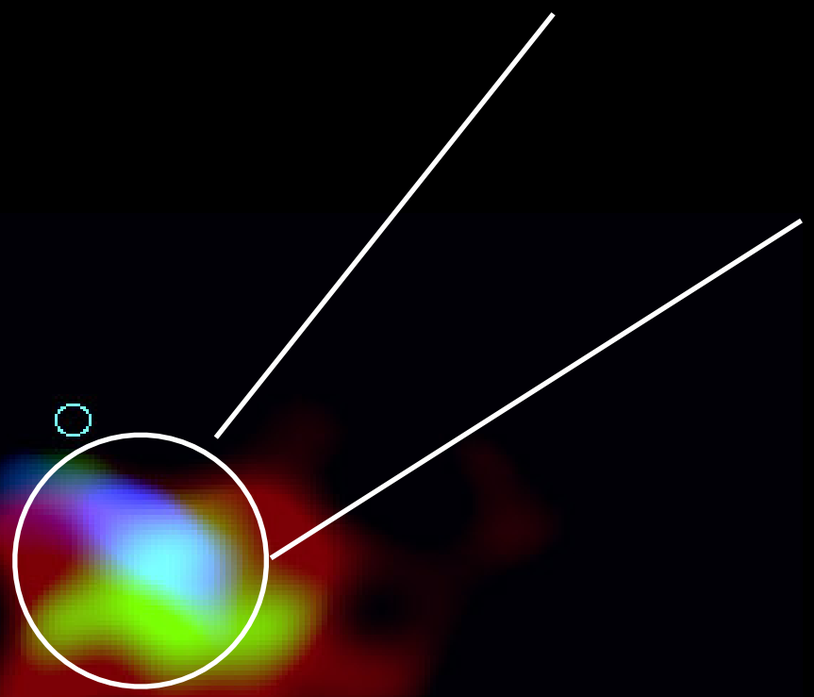
> 2.5 TeV
1 – 2.5 TeV
< 1 TeV



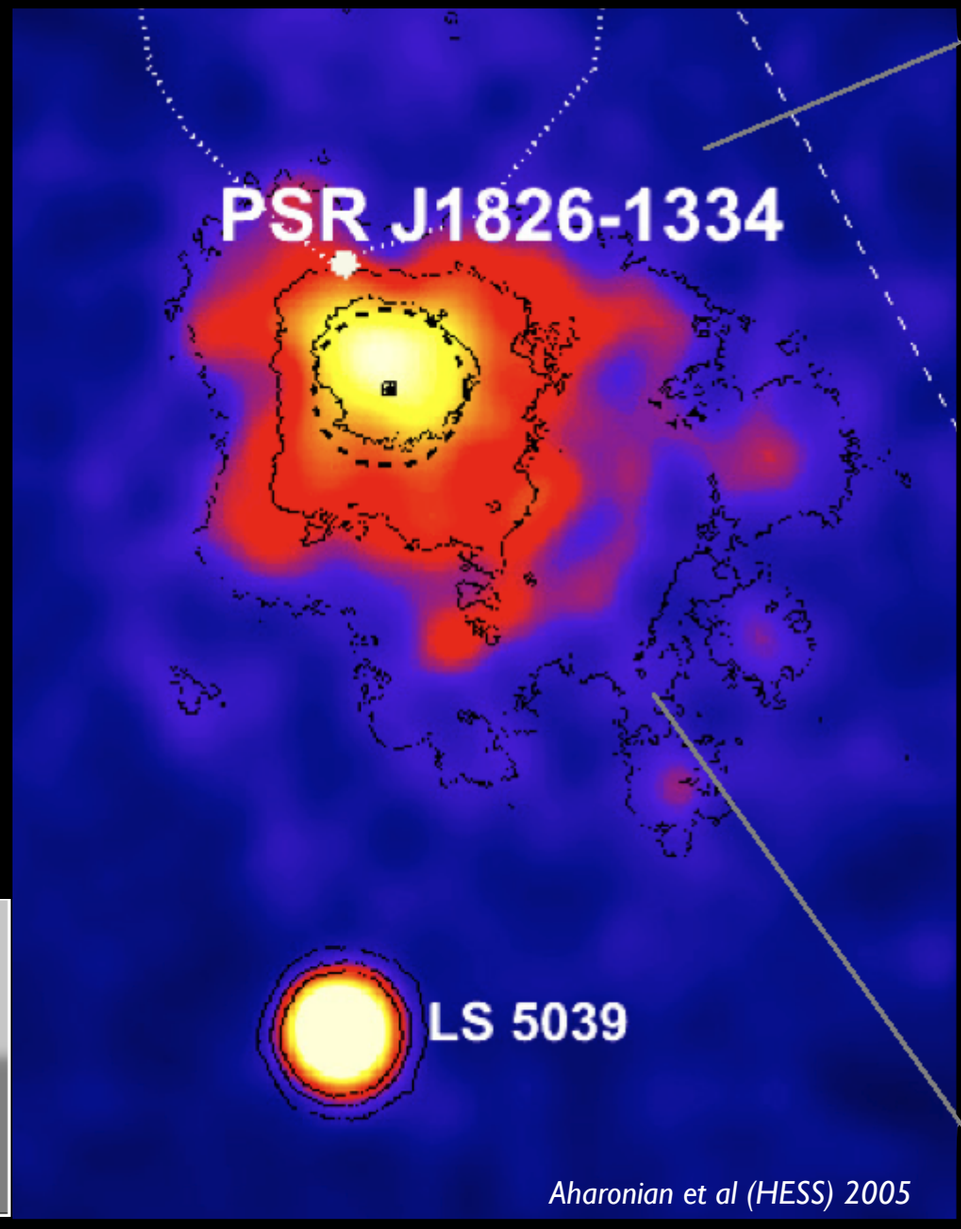


Source Type: Relic PWNe

21 kys

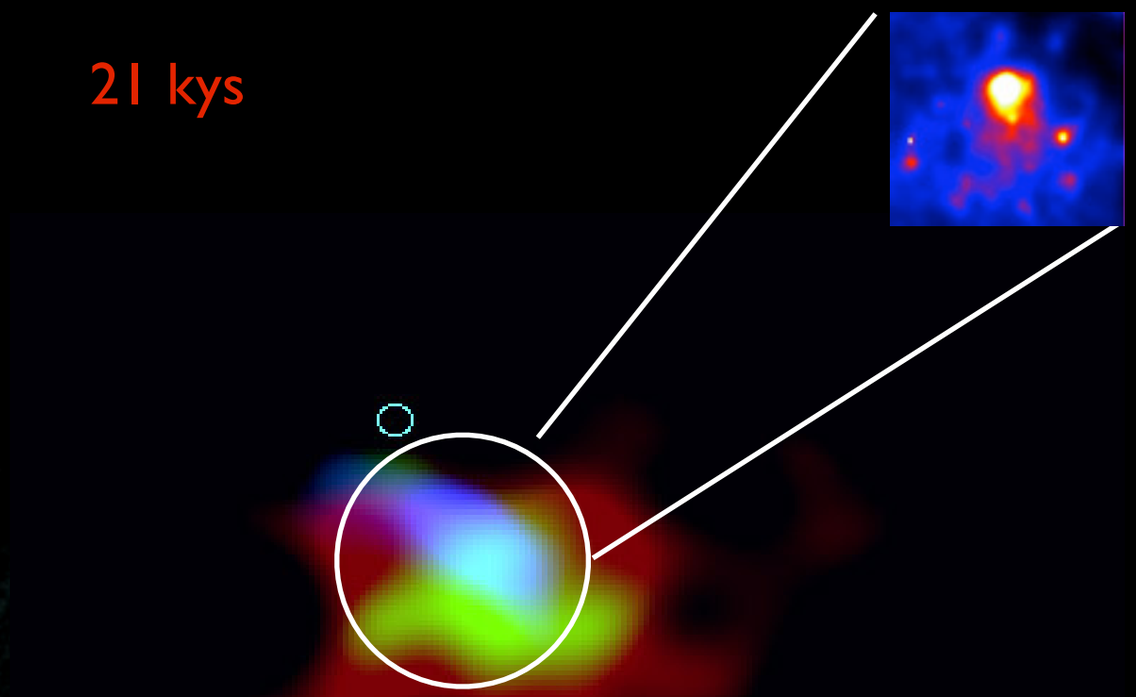


> 2.5 TeV
1 – 2.5 TeV
< 1 TeV

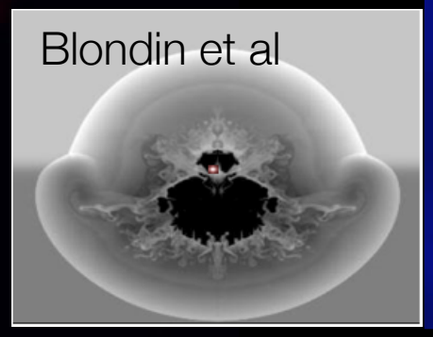


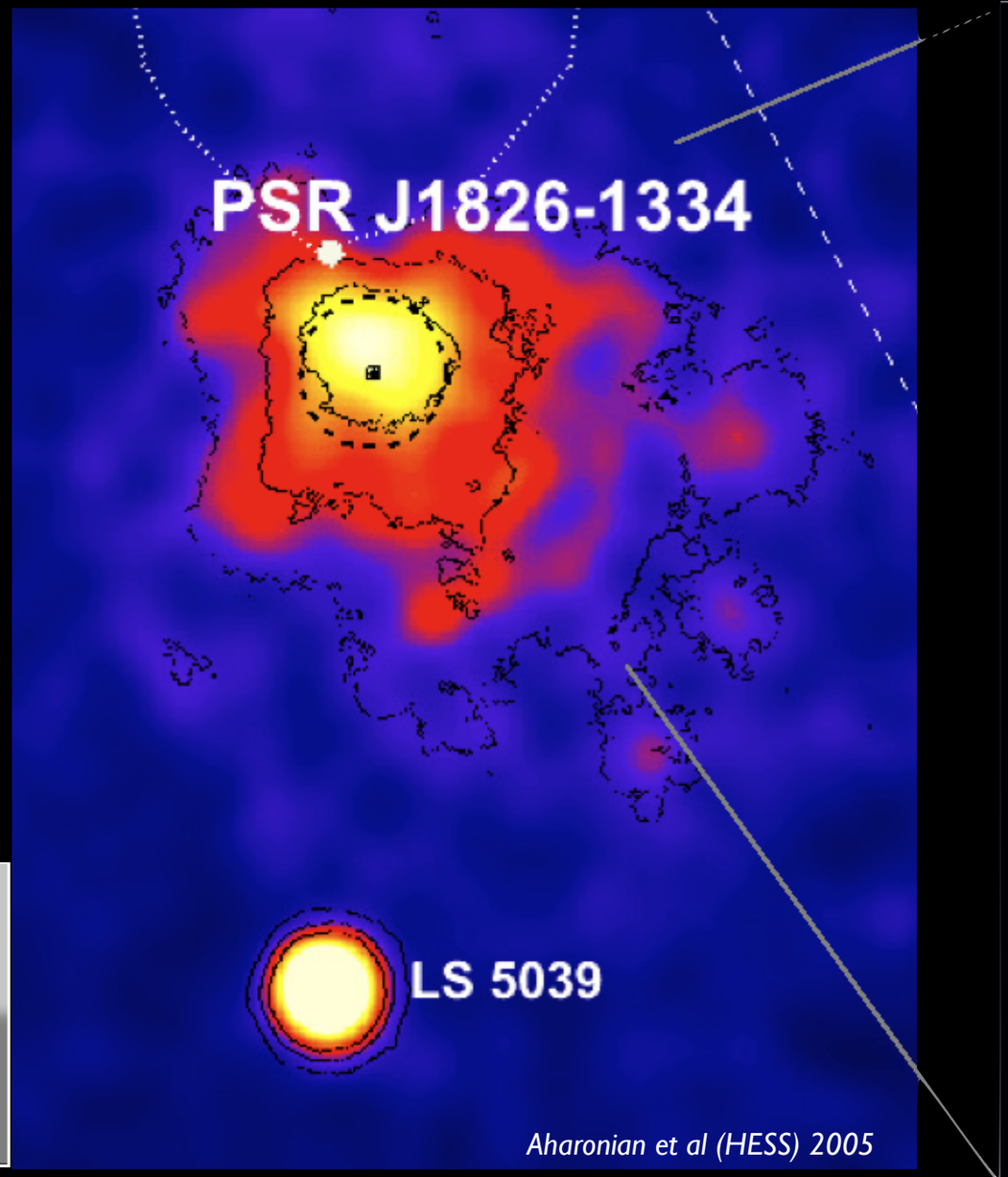
Source Type: Relic PWNe

21 kys



> 2.5 TeV
1 – 2.5 TeV
< 1 TeV



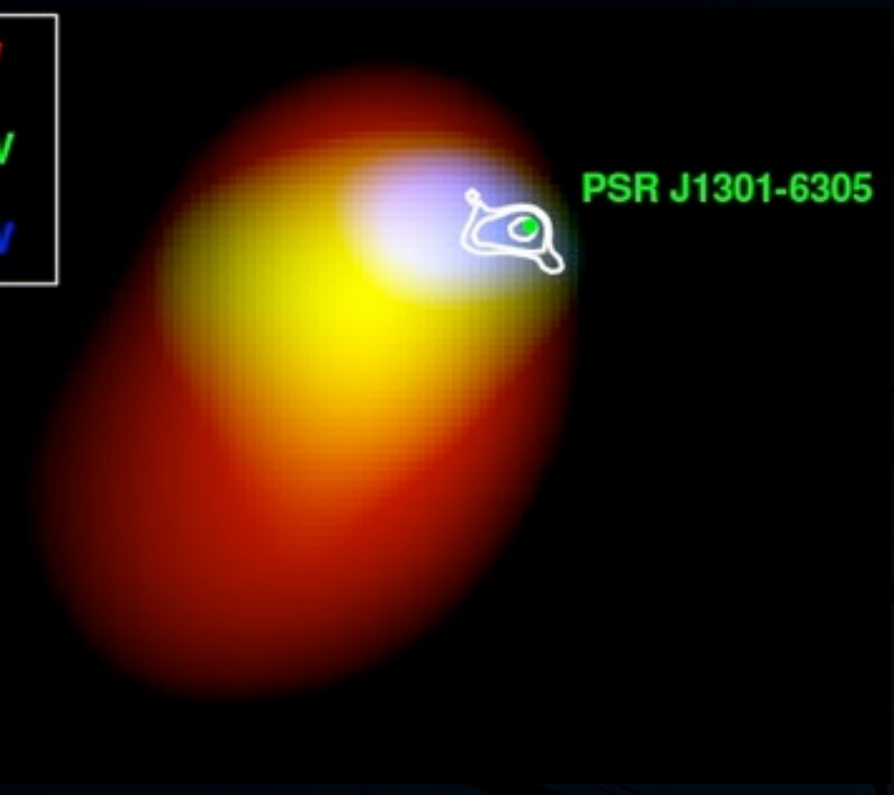


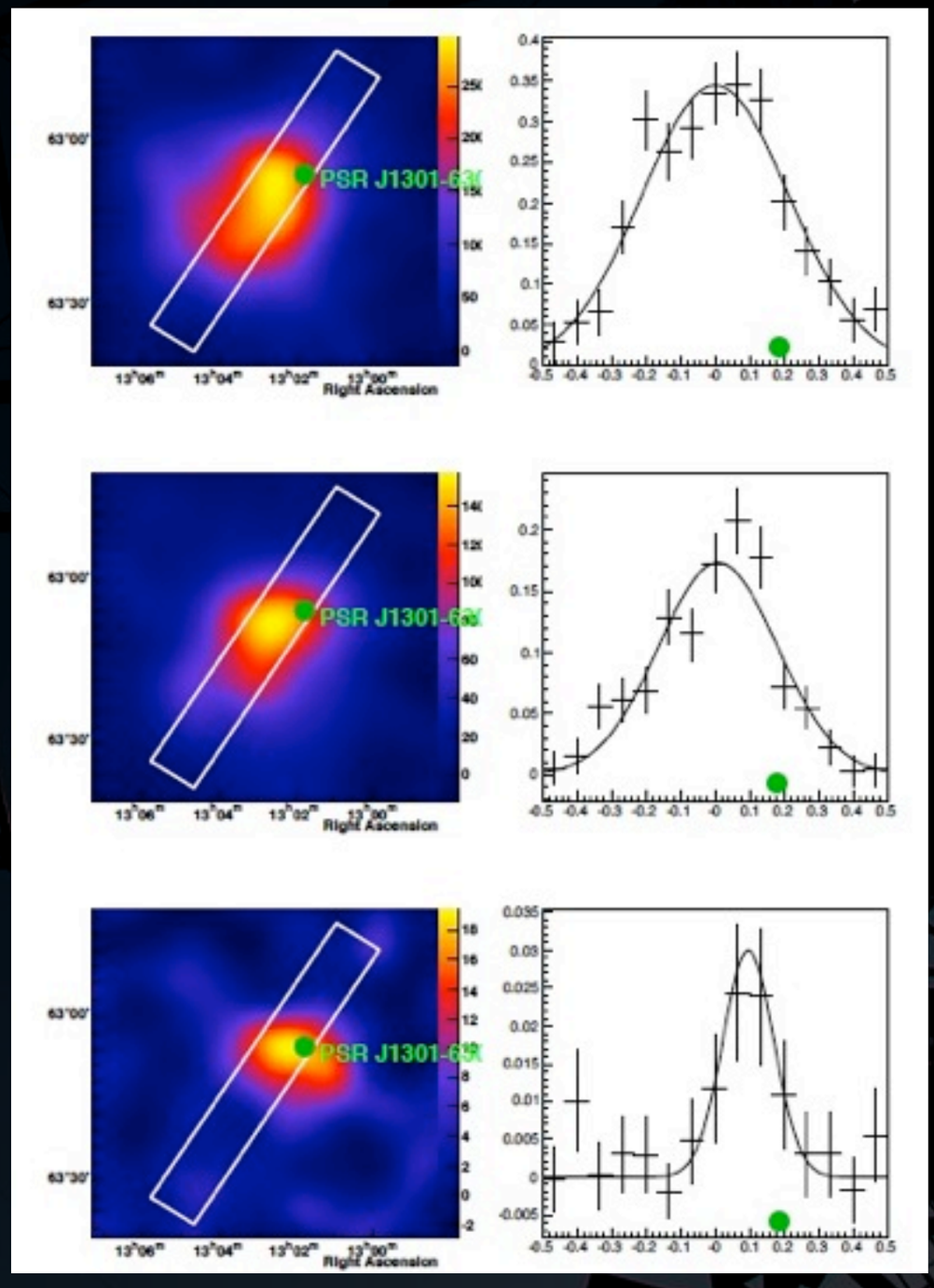
Source Type: Relic PWNe

E < 2 TeV

E 2-10 TeV

E > 10 TeV





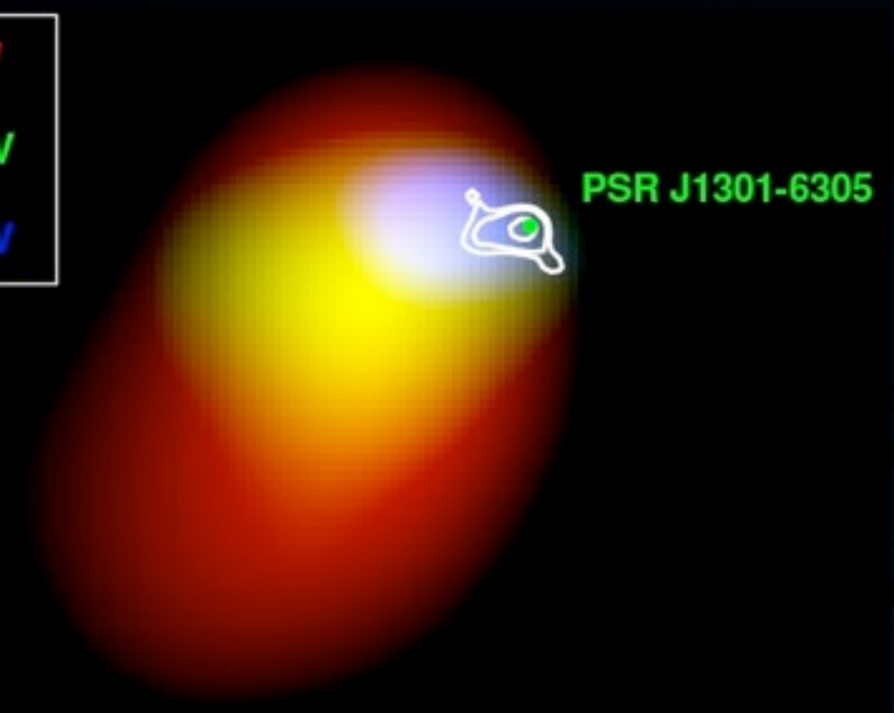
Acero et al (HESS) 2011

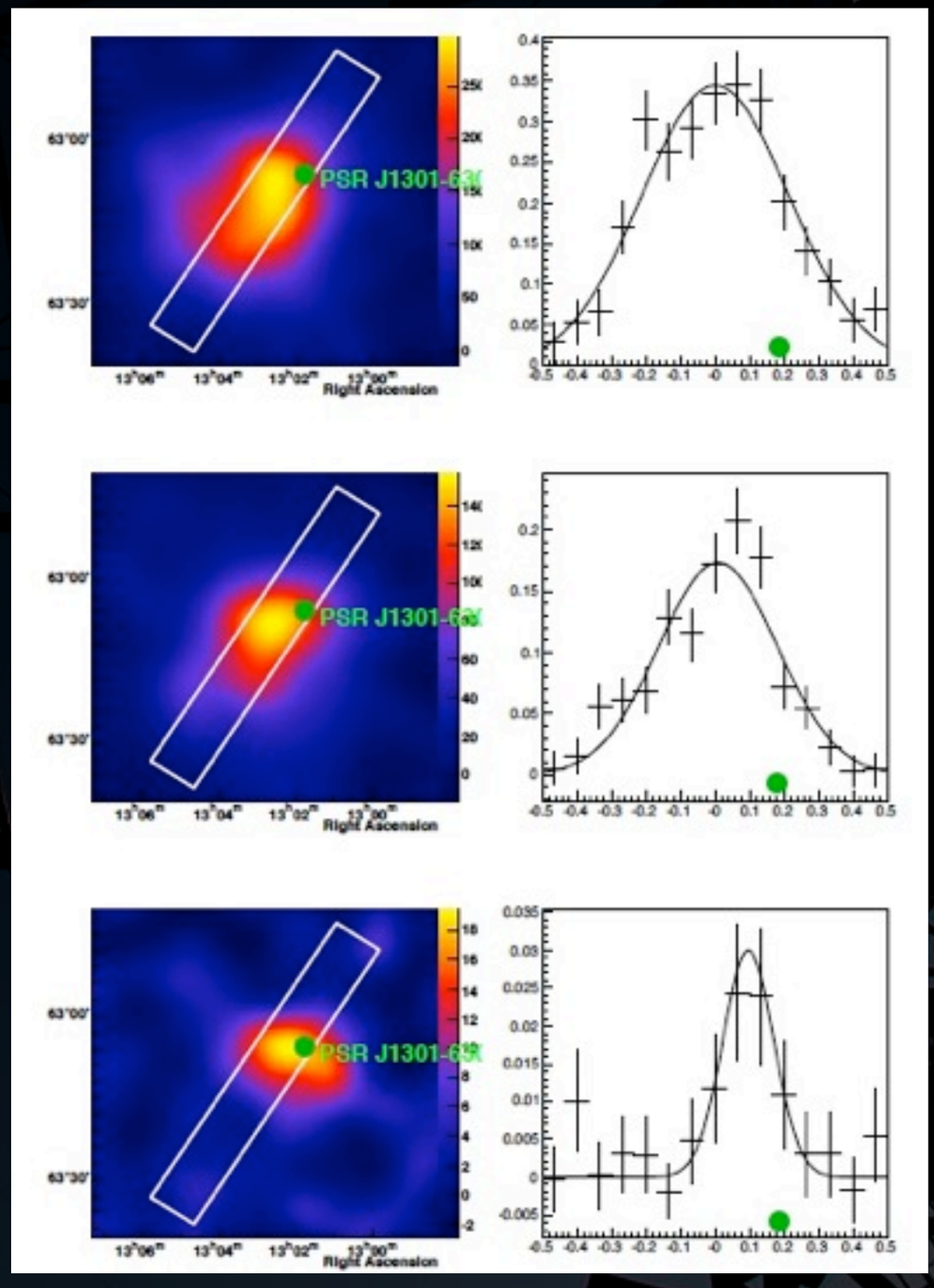
Source Type: Relic PWNe

E < 2 TeV

E 2-10 TeV

E > 10 TeV



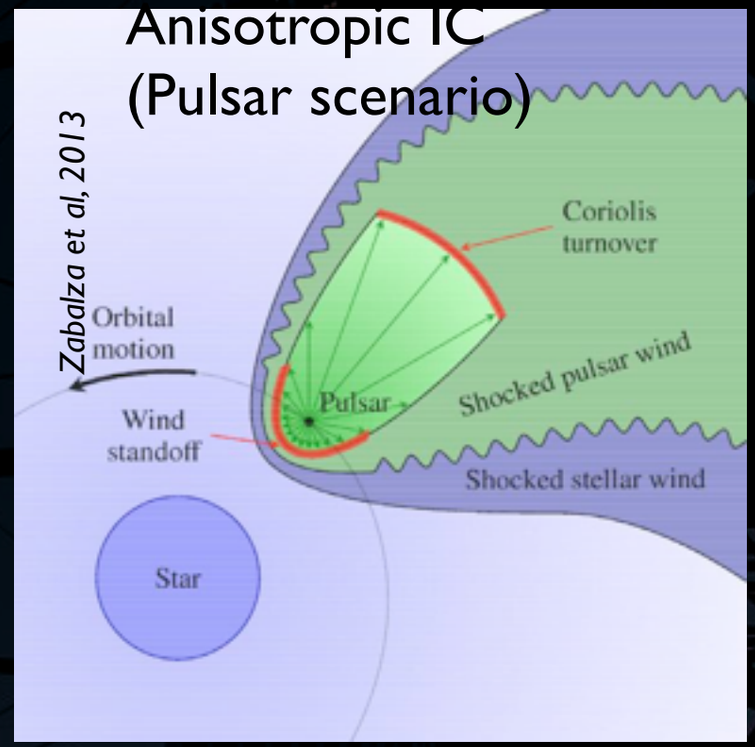


Acero et al (HESS) 2011

- Shrinking towards high energies

Source Type: Binary Systems

- Point-like Sources at VHE:
  neutron star or black hole + massive companion
- Modulation of the VHE due to their interaction (6)
  Observed in radio, X-ray, HE and VHE
- Difficult to reconcile all observations
- Not a unique behavior: Ej. **LS 5039 vs 1FGL J1018.6**

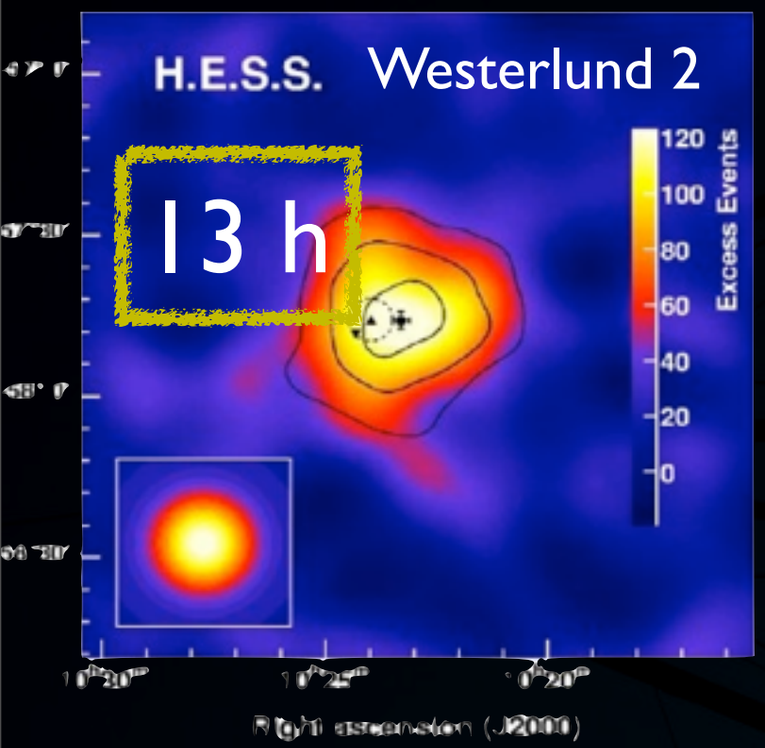



Microquasar scenario

	Flux (% Crab)	D (Kpc)	Flux variability (HE/VHE)	Periodic
LSI +61 303	0-15	2	yes/yes	yes (~1 month)
LS 5039	5-15	2.5	yes/yes	yes (~4 days)
PSR B1259-63	0-10	1.5	yes/yes	yes (~3.4 years)
HESS J0632+057	0-3	1.5	no/yes	yes (~300 days)
Cyg X-1	0-10	2.2	yes/yes(?)	no
1FGL J1018.6-589	5-15	5	yes/?	yes (~16 days)

HESS J1018-589 (1FGL J1018.6-589) vs LS 5039

Discovered in the GPS...

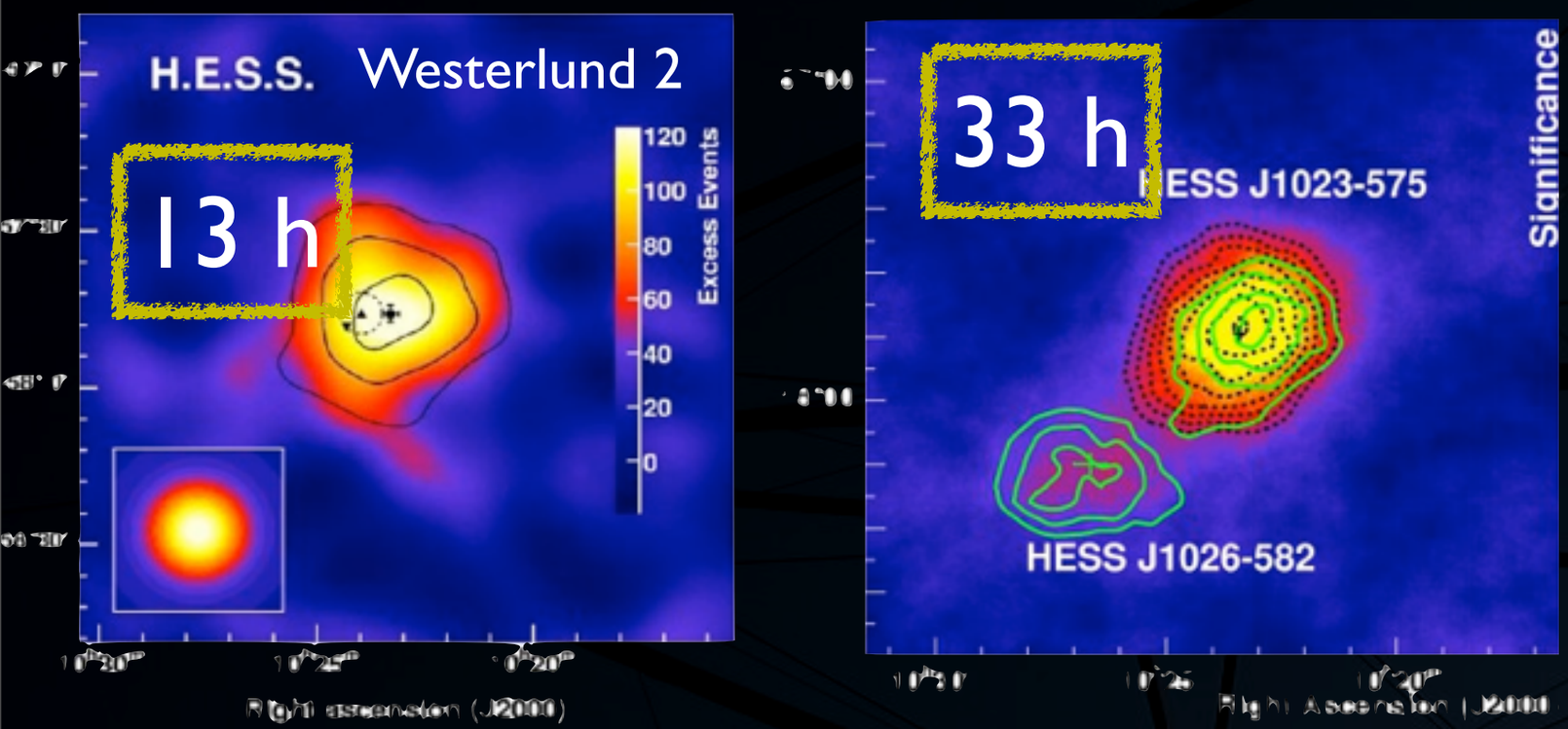


Kaufzo et al, 2013

HESS J1018 A = 1FGL 1018.6-5859

HESS J1018-589 (1FGL J1018.6-589) vs LS 5039

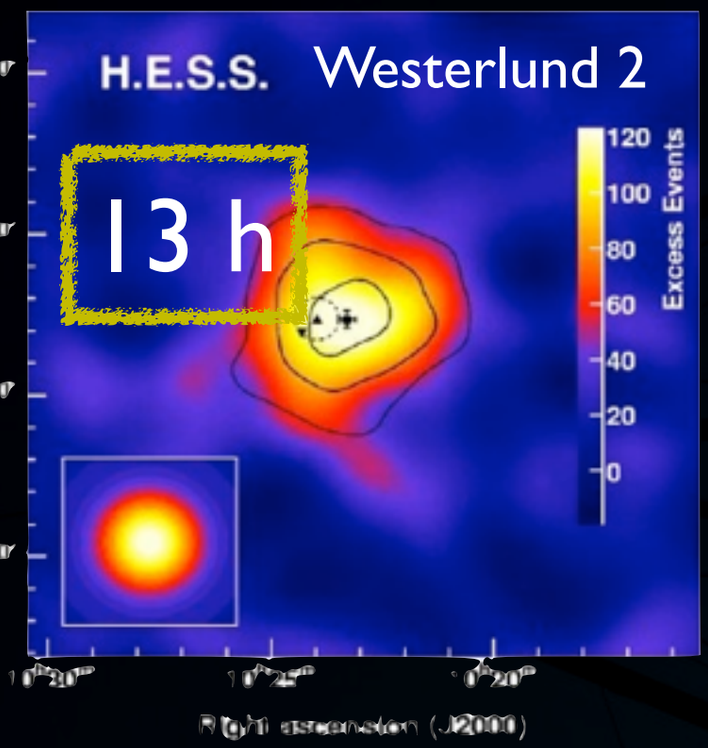
Discovered in the GPS...

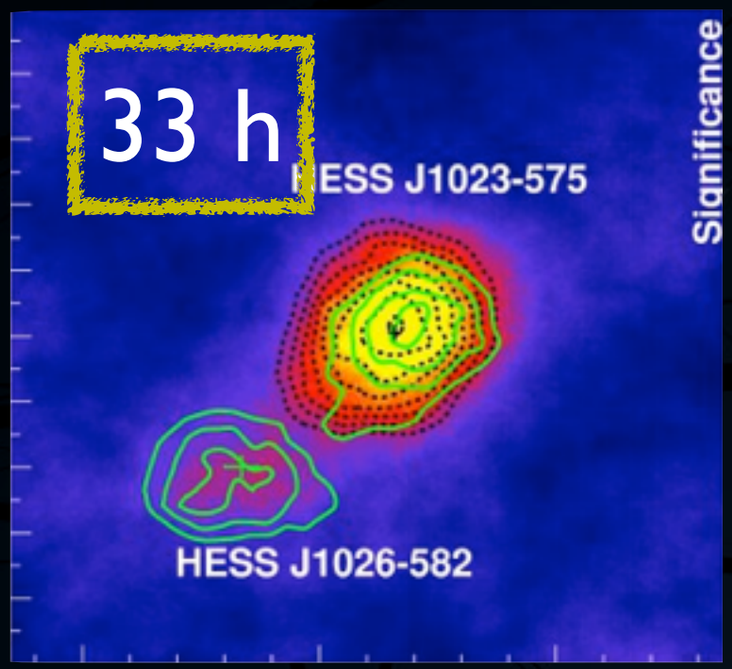


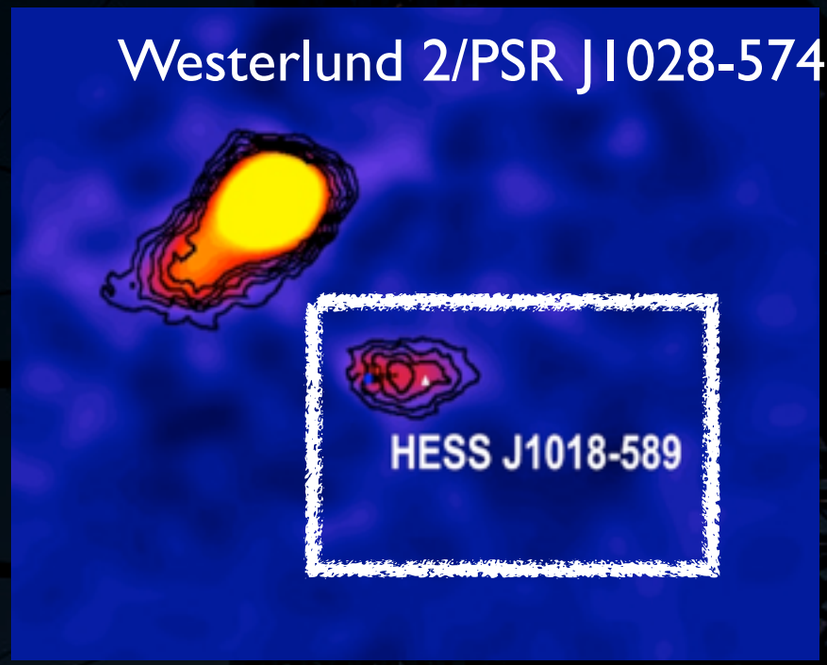
HESS J1018 A = 1FGL 1018.6-5859

HESS J1018-589 (1FGL J1018.6-589) vs LS 5039

Discovered in the GPS...



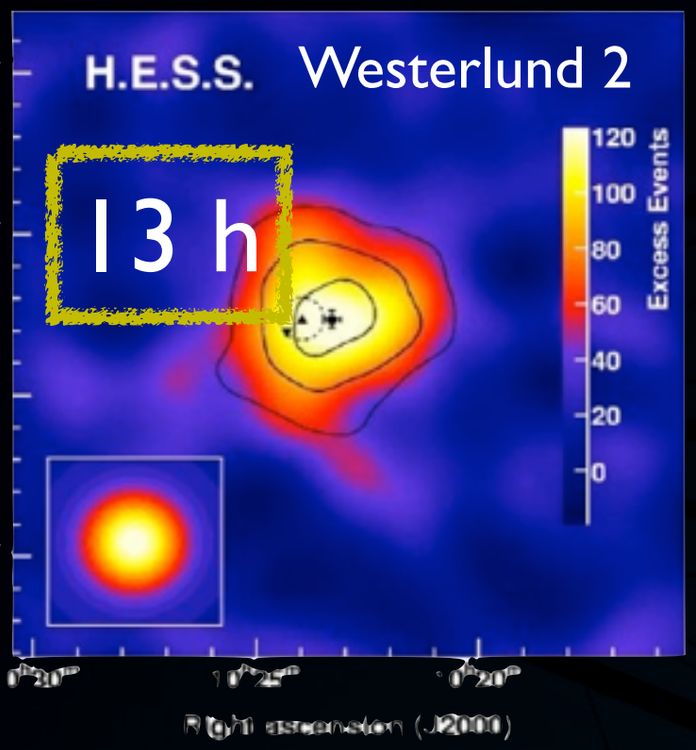


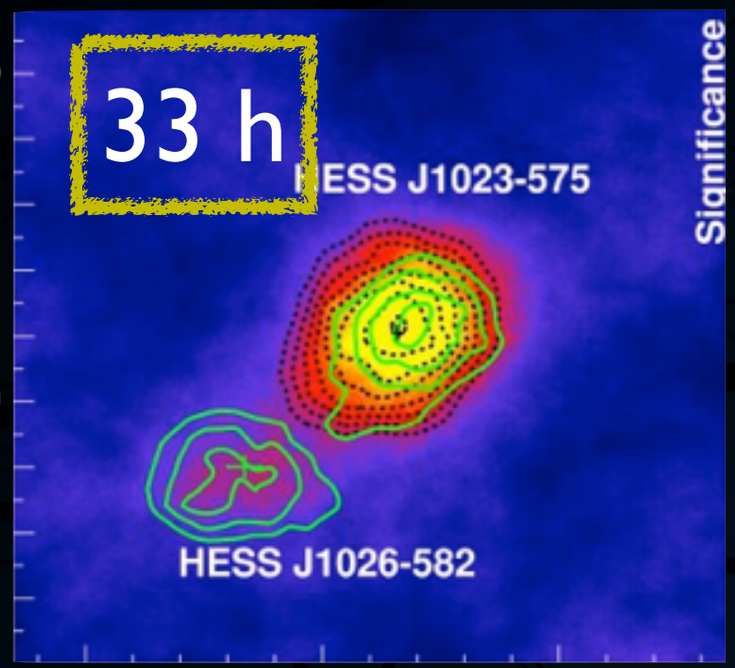


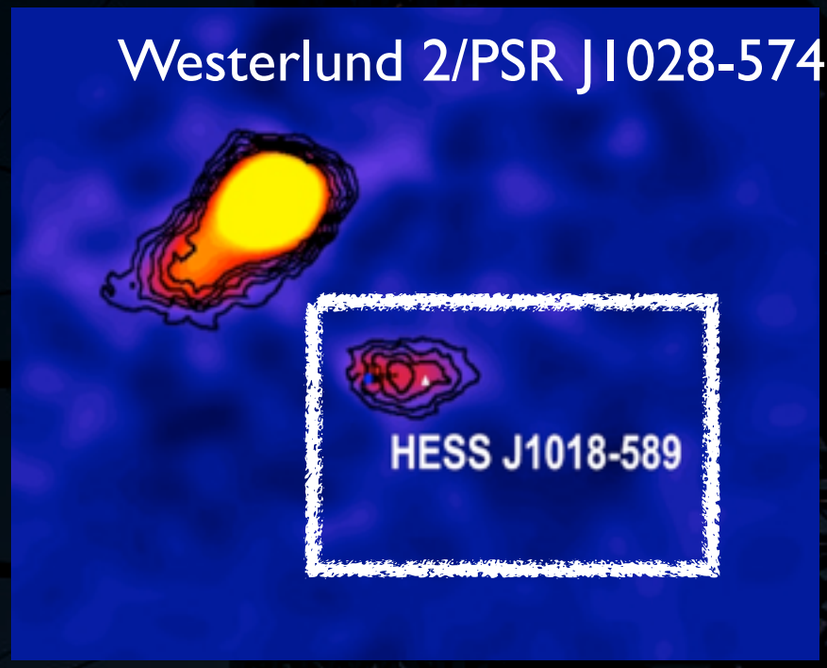
HESS J1018 A = 1FGL 1018.6-5859

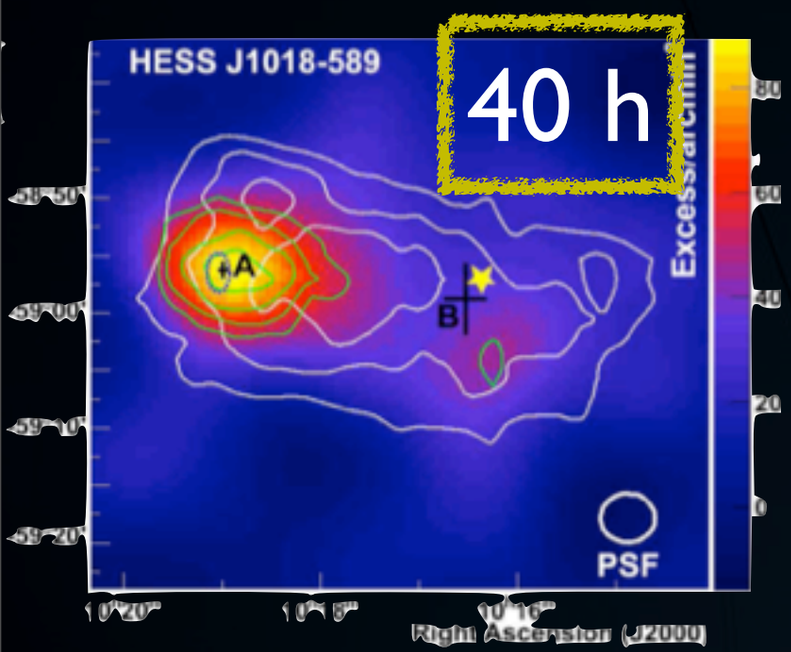
HESS J1018-589 (1FGL J1018.6-589) vs LS 5039

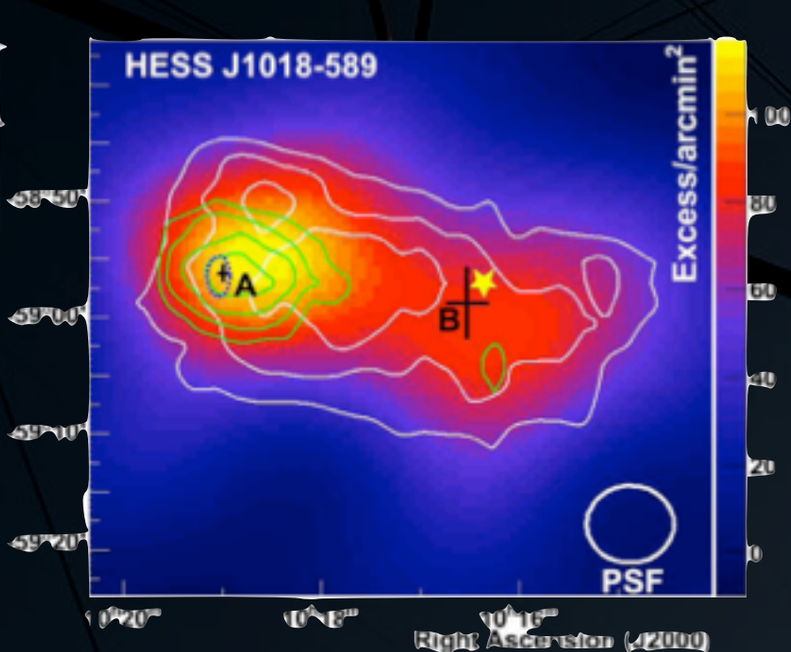
Discovered in the GPS...







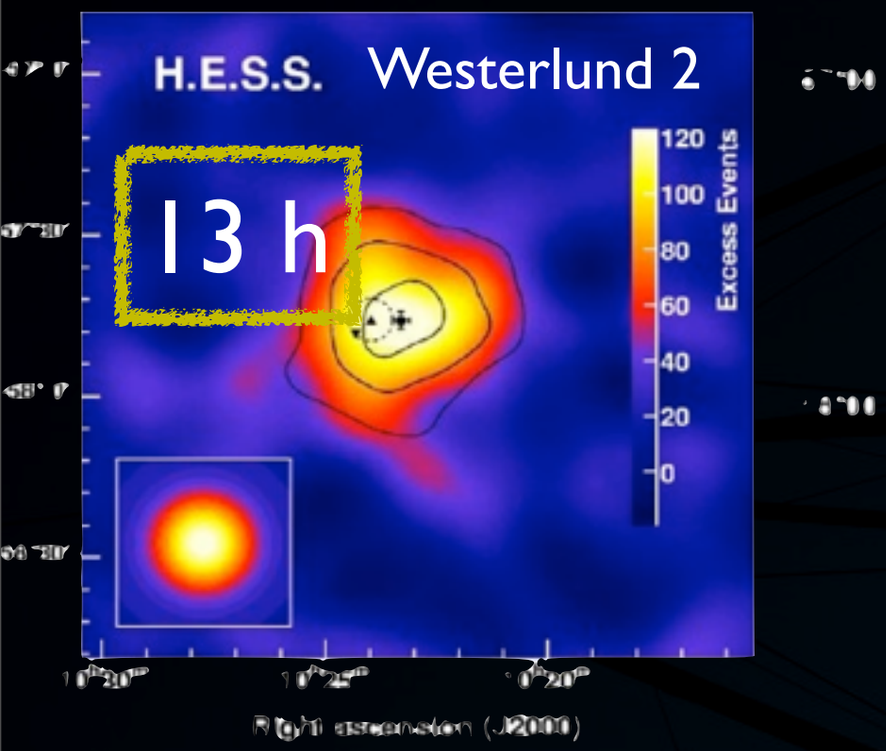


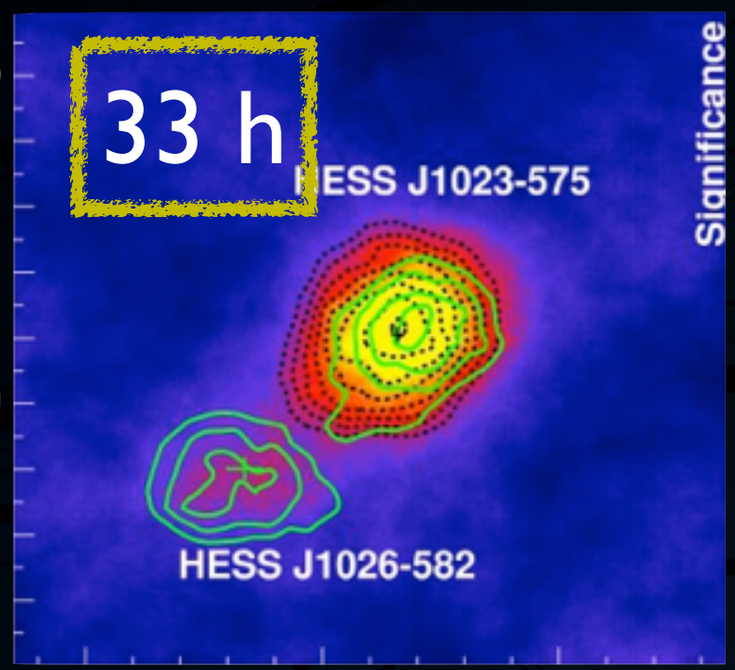


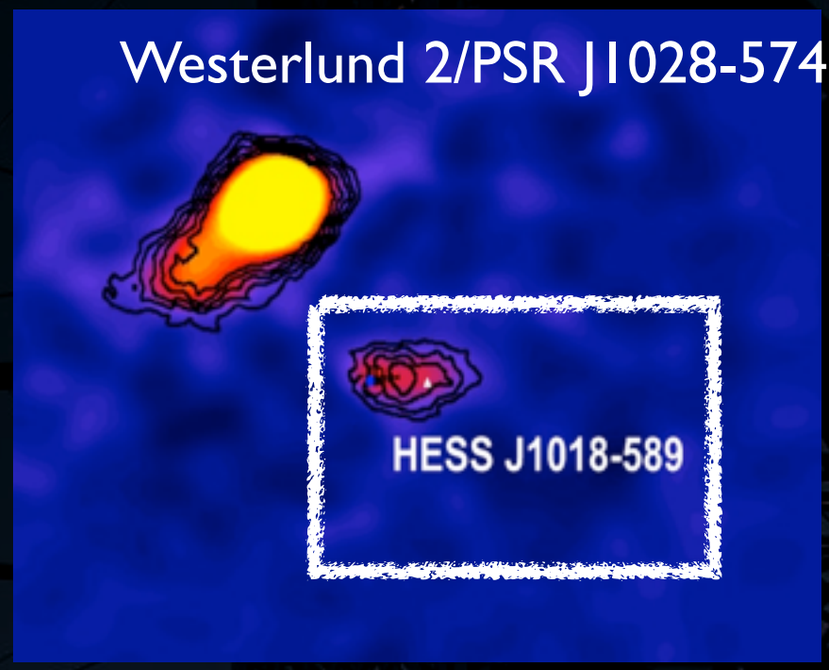
HESS J1018 A = 1FGL 1018.6-5859

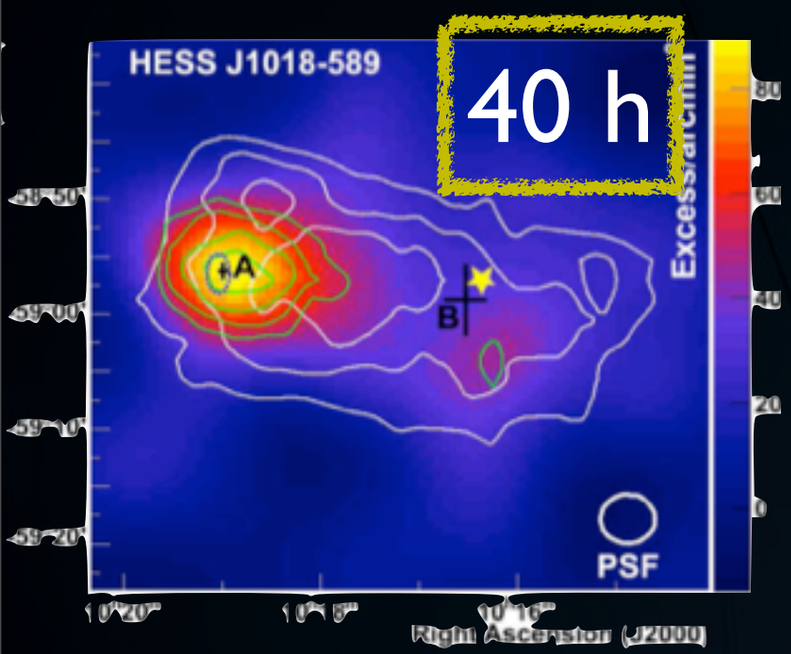
HESS J1018-589 (1FGL J1018.6-589) vs LS 5039

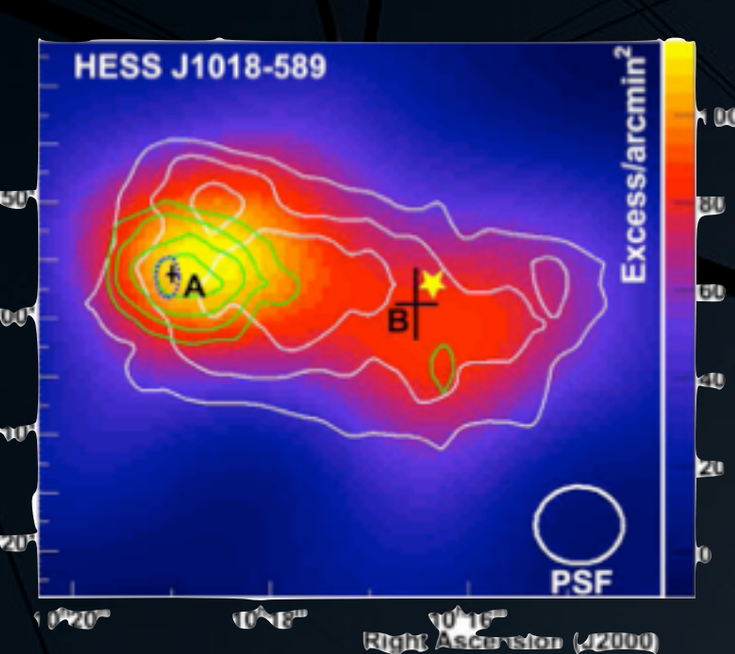
Discovered in the GPS...

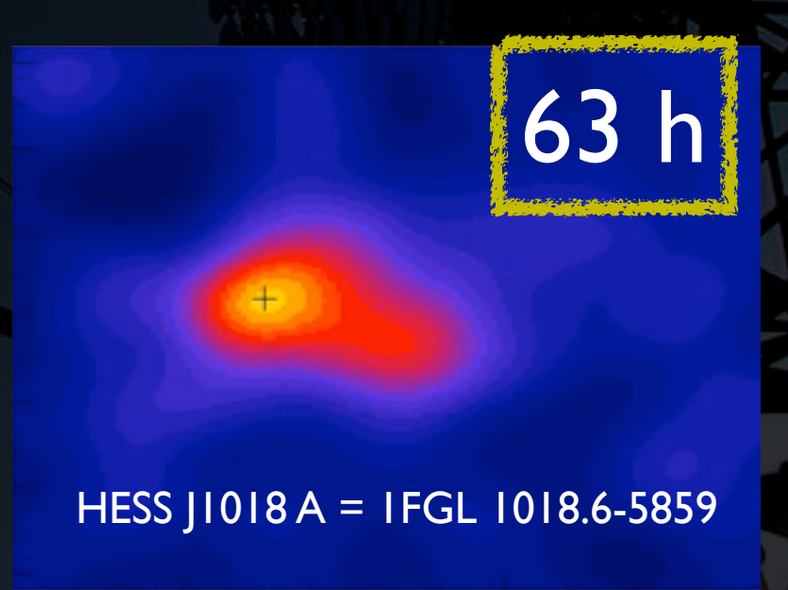








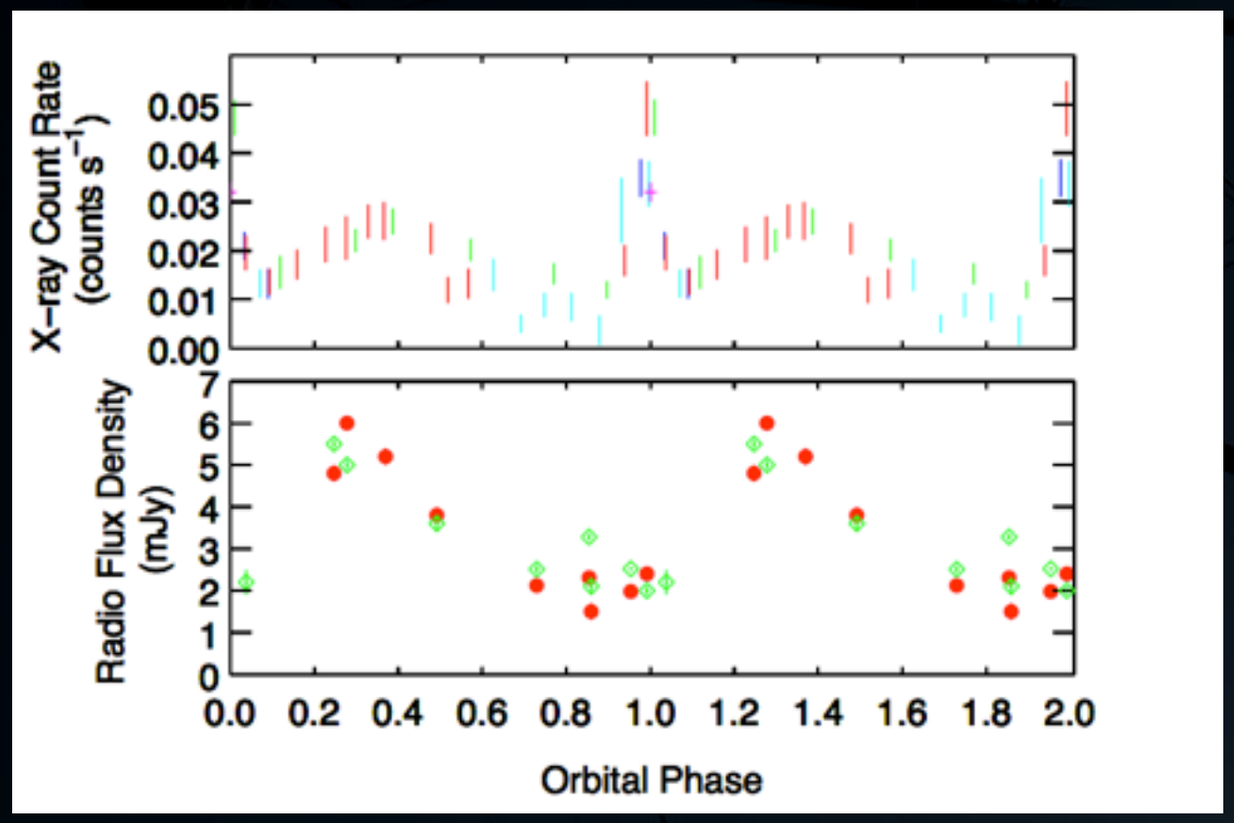


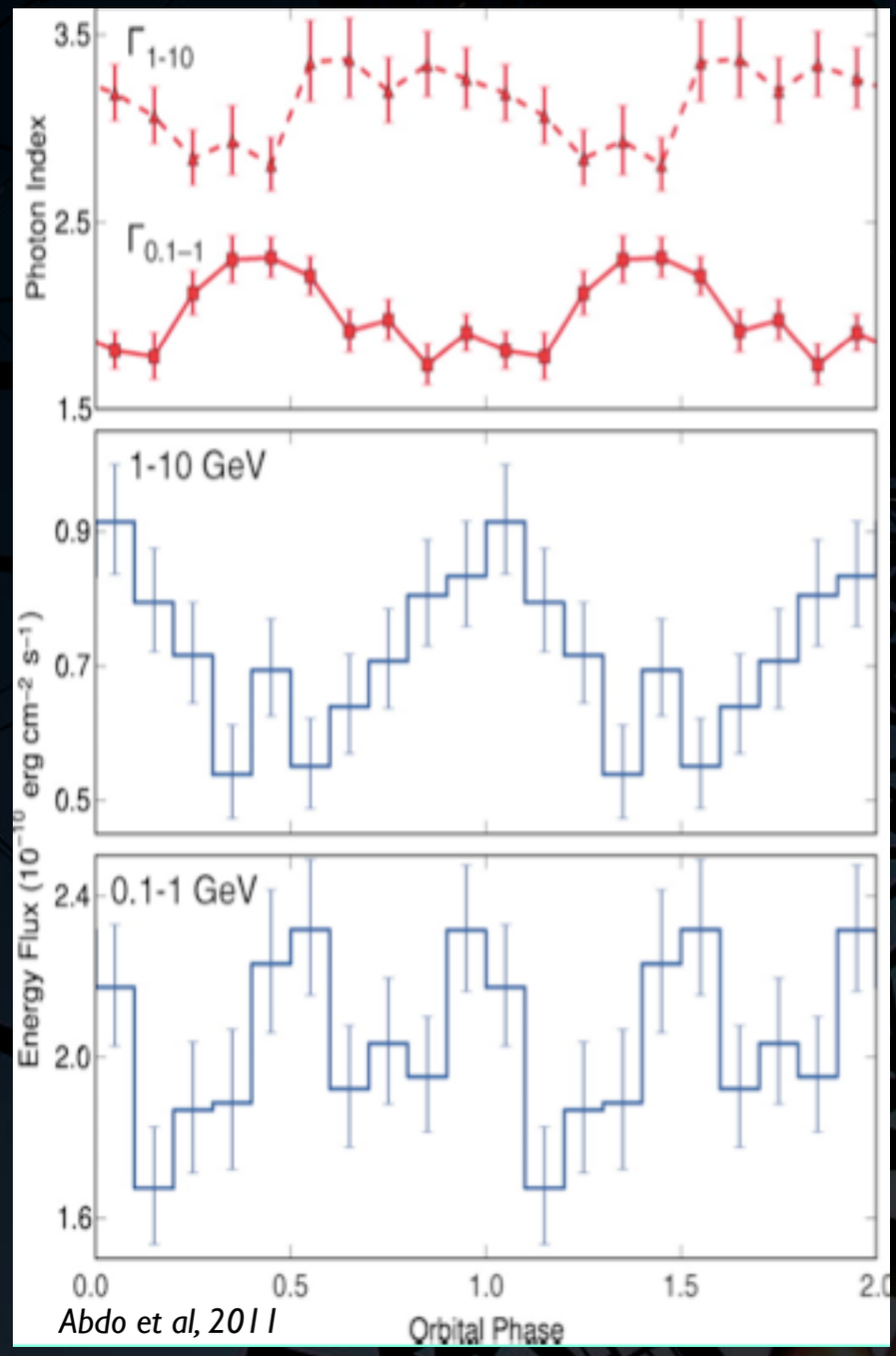


HESS J1018-589 (1FGL J1018.6-589) vs LS 5039

1FGL J1018.6-589

- Discovered in the Fermi LAT data
- Compact object + Massive star O6V((f))
- Period = 16.6 days
- Orbital Parameters still unknown
- (Periodic) Variability observed too in X-ray and radio



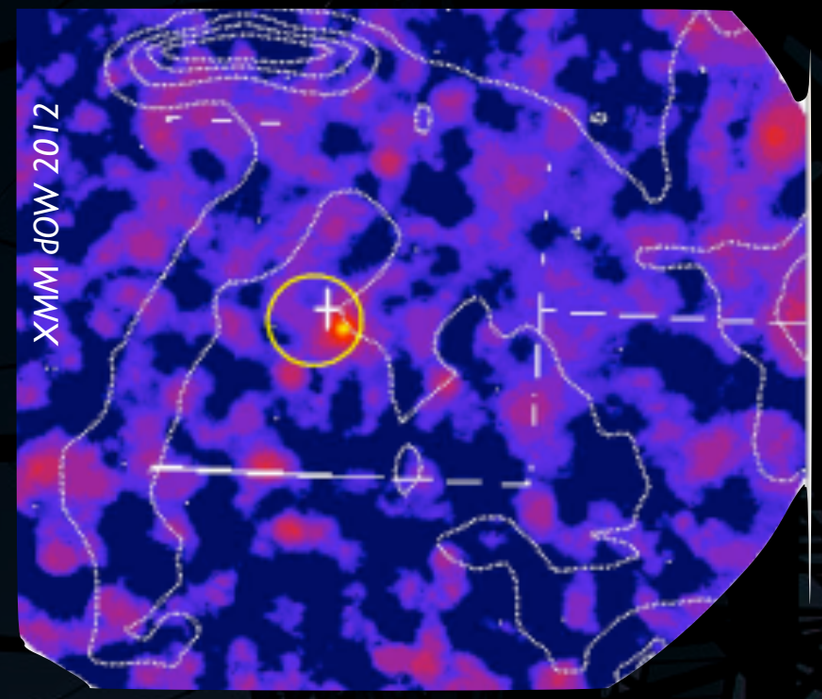


Abdo et al, 2011

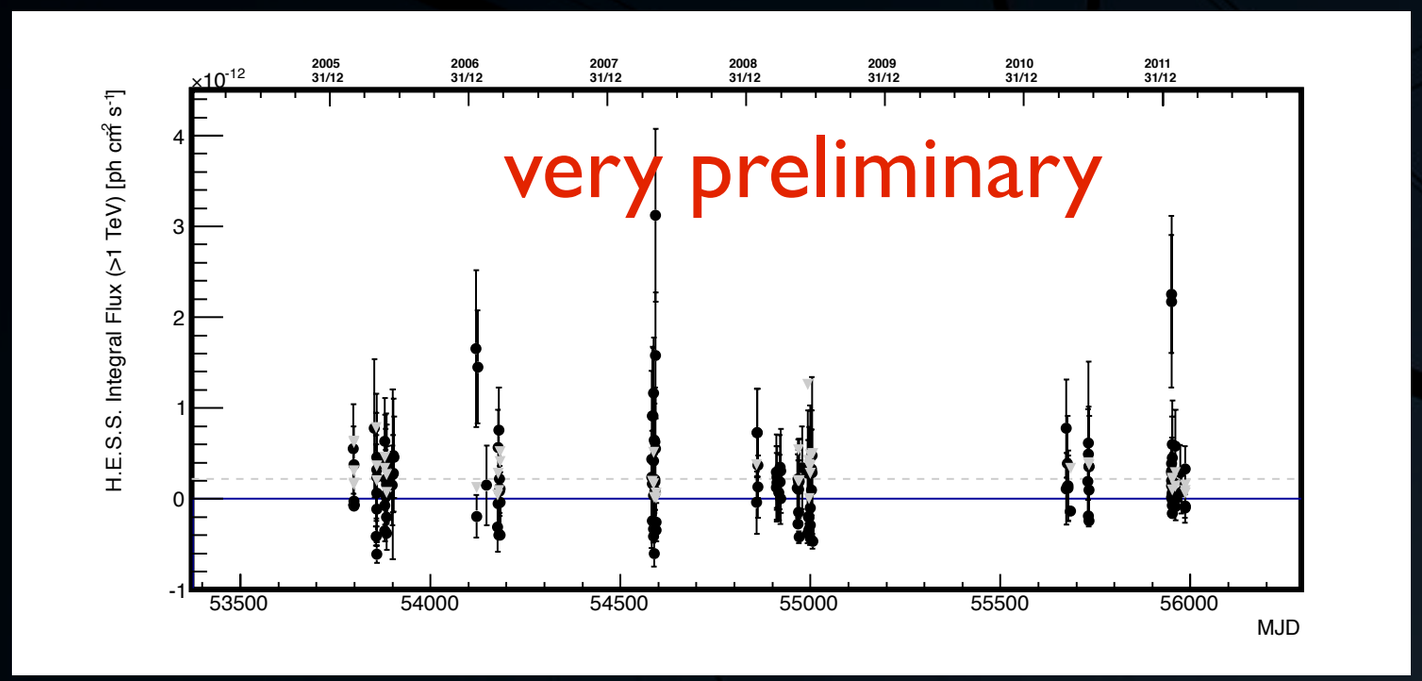
HESS J1018-589 (1FGL J1018.6-589) vs LS 5039

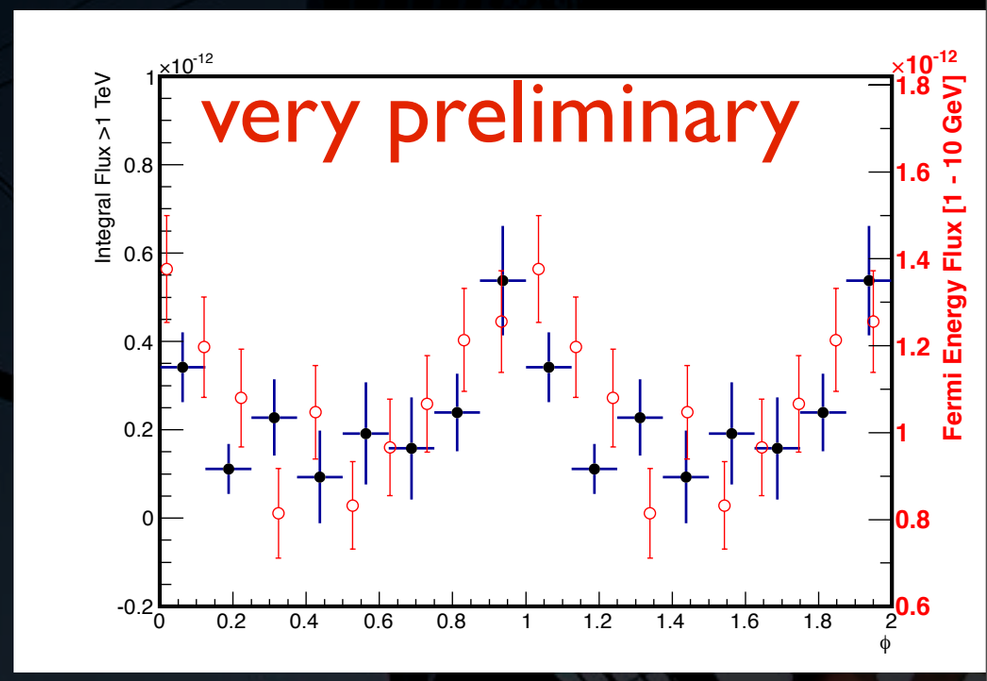
1FGL J1018.6-589

- Discovered in the Fermi LAT data
- Compact object + Massive star O6V((f))
- Period = 16.6 days
- Orbital Parameters still unknown
- (Periodic) Variability observed too in X-ray and radio



HESS J1018-589



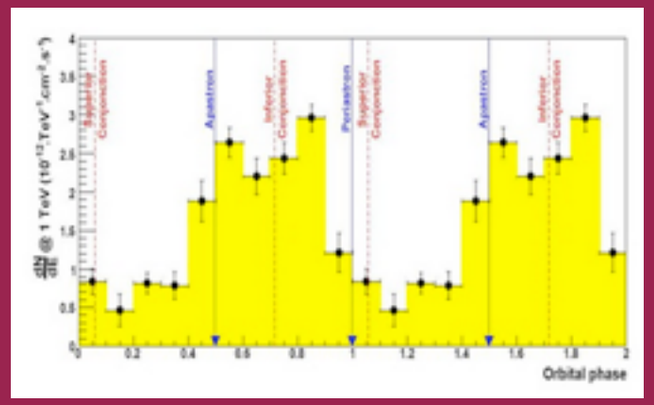


LS 5039

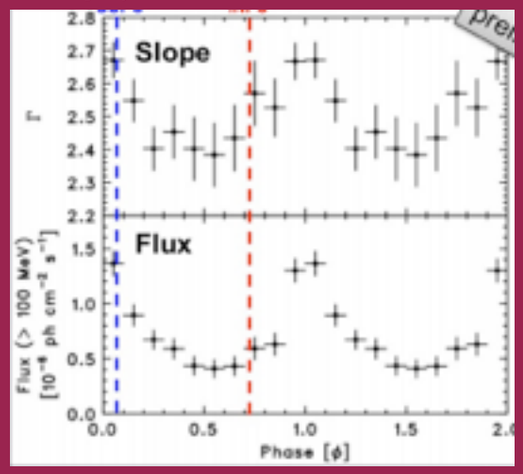
Compact object + O6V((f))

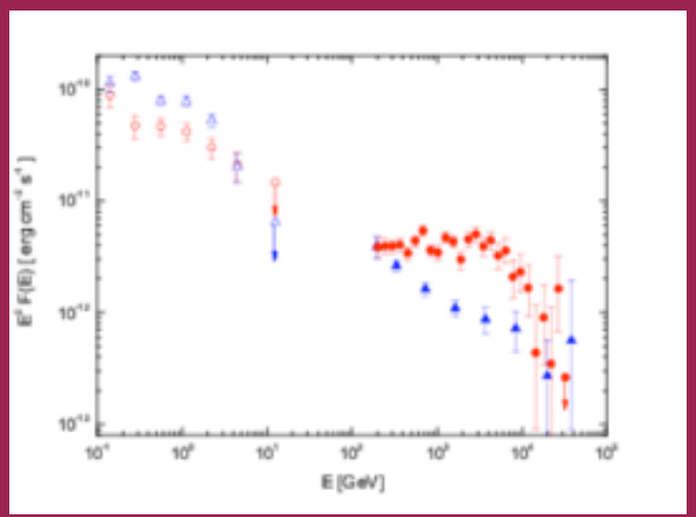
P ~ few days (~4days)

TeV

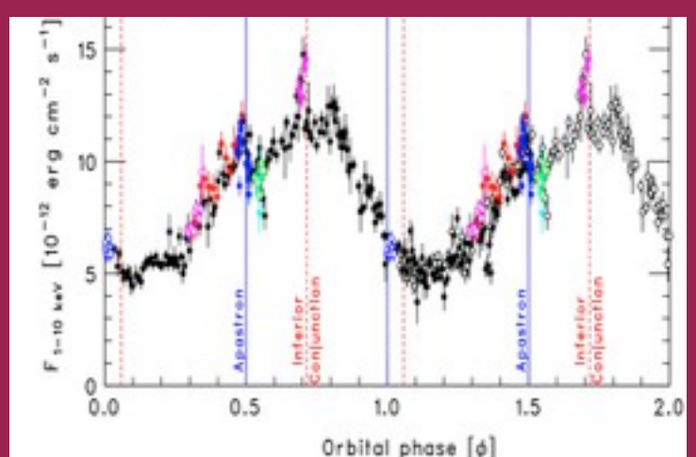


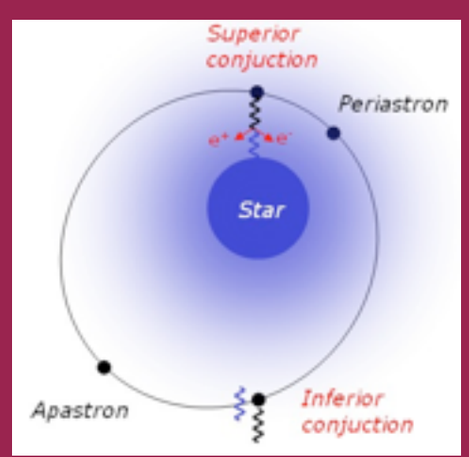
GeV





$L_{GeV} = 2 \times 10^{35} (d/2.5)^2$ erg/s
$L_{Xray} = 5 \times 10^{34} (d/2.5)^2$ erg/s
$L_{VHE} = 1 \times 10^{33} (d/2.5)^2$ erg/s



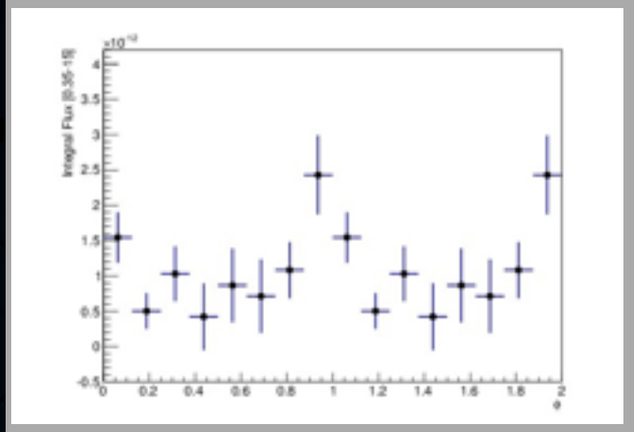


1FGL J1018.6-5856

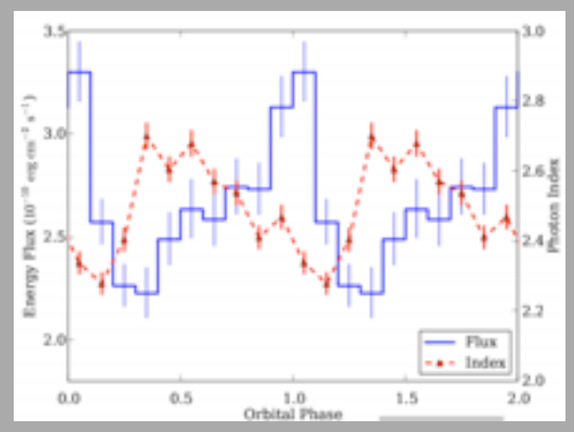
Compact object +O6V((f))

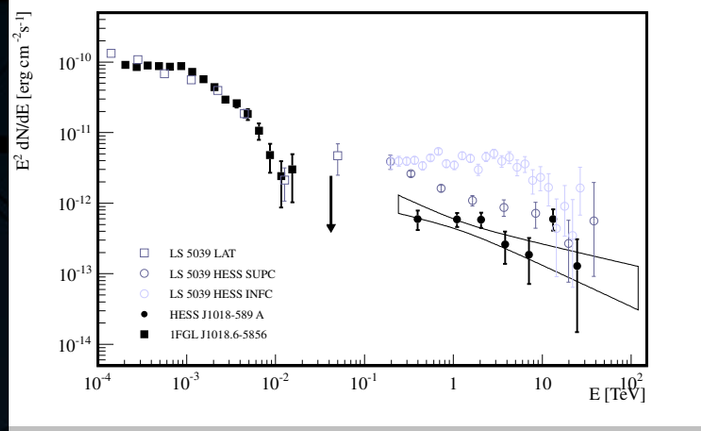
P ~ few days (~16 days) Maxis~2.5 larger

TeV

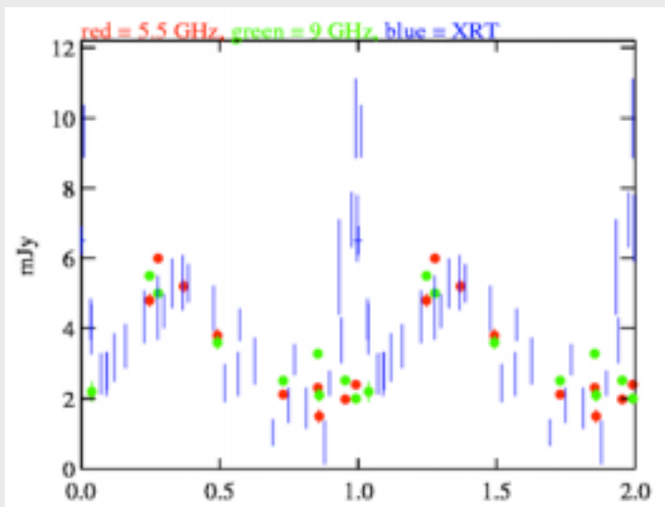


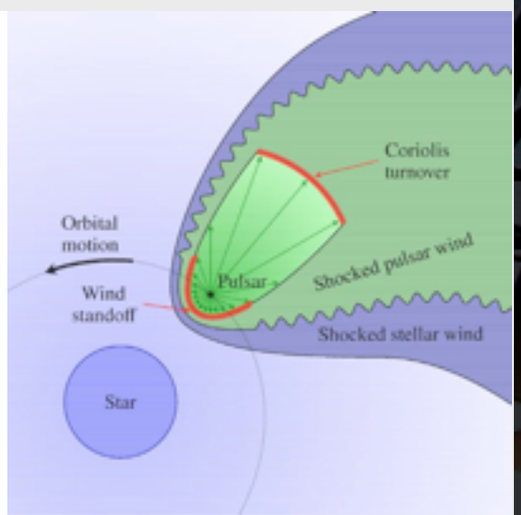
GeV



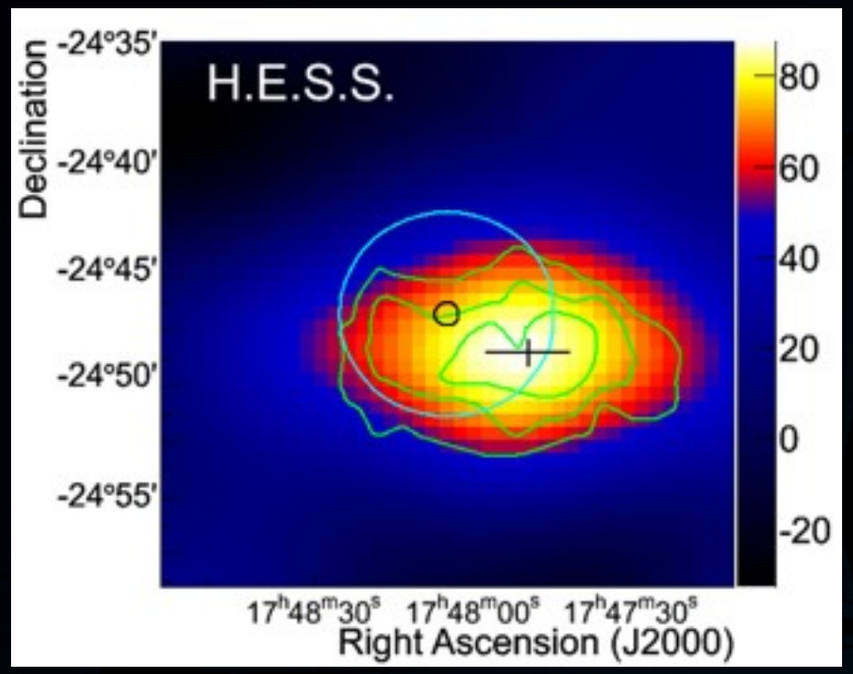


$L_{GeV} = 8 \times 10^{35} (d/5)^2$ erg/s
$L_{Xray} = 2 \times 10^{33} (d/5)^2$ erg/s
$L_{VHE} = 1 \times 10^{33} (d/5)^2$ erg/s





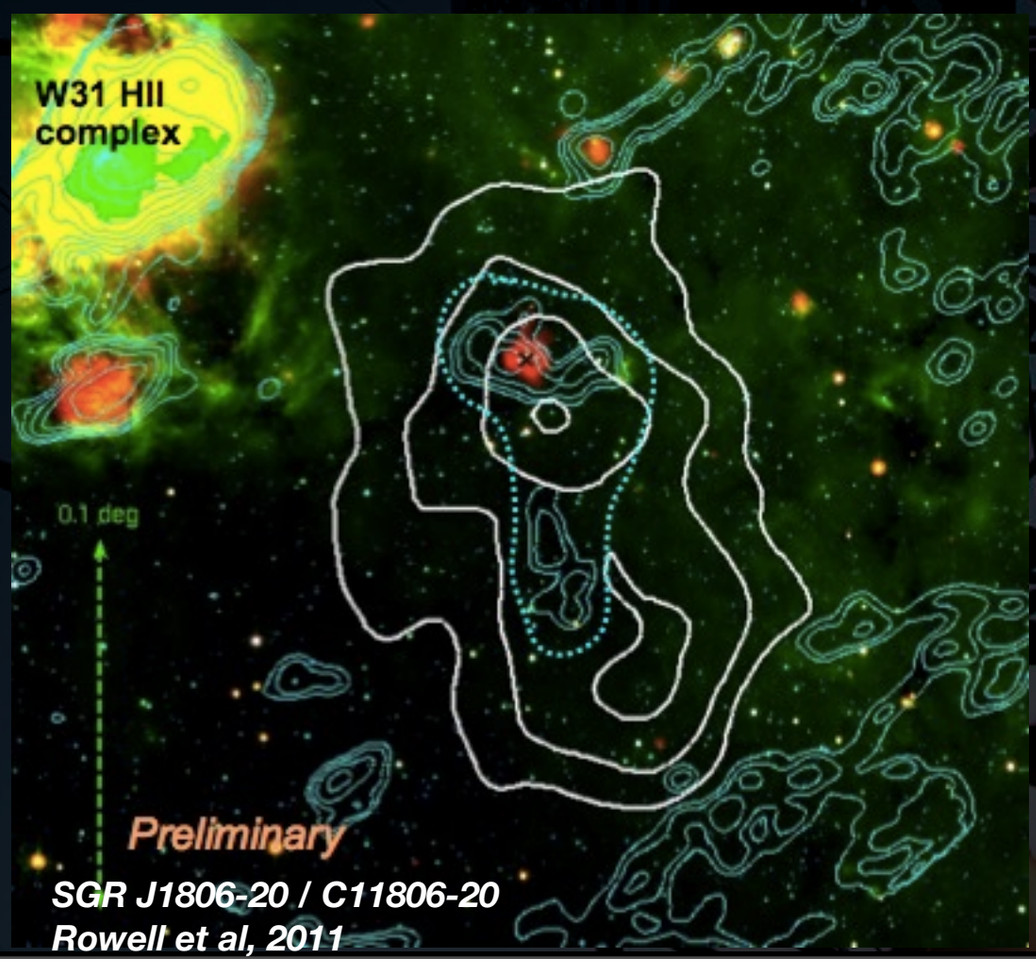
New source types?



HESS J1747-248
Abramowski et al, 2011

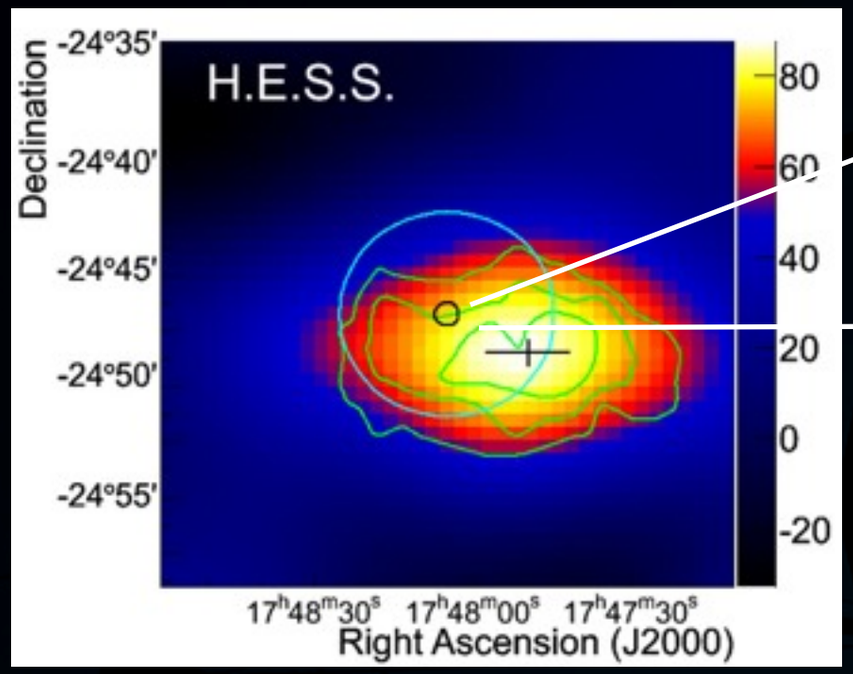
Pulsars back on the game?

Magnetar: B=$10^{14\text{-}15}$ G (SGR)
Member of stellar cluster C1 1806-20



SGR J1806-20 / C11806-20
Rowell et al, 2011

New source types?



HESS J1747-248
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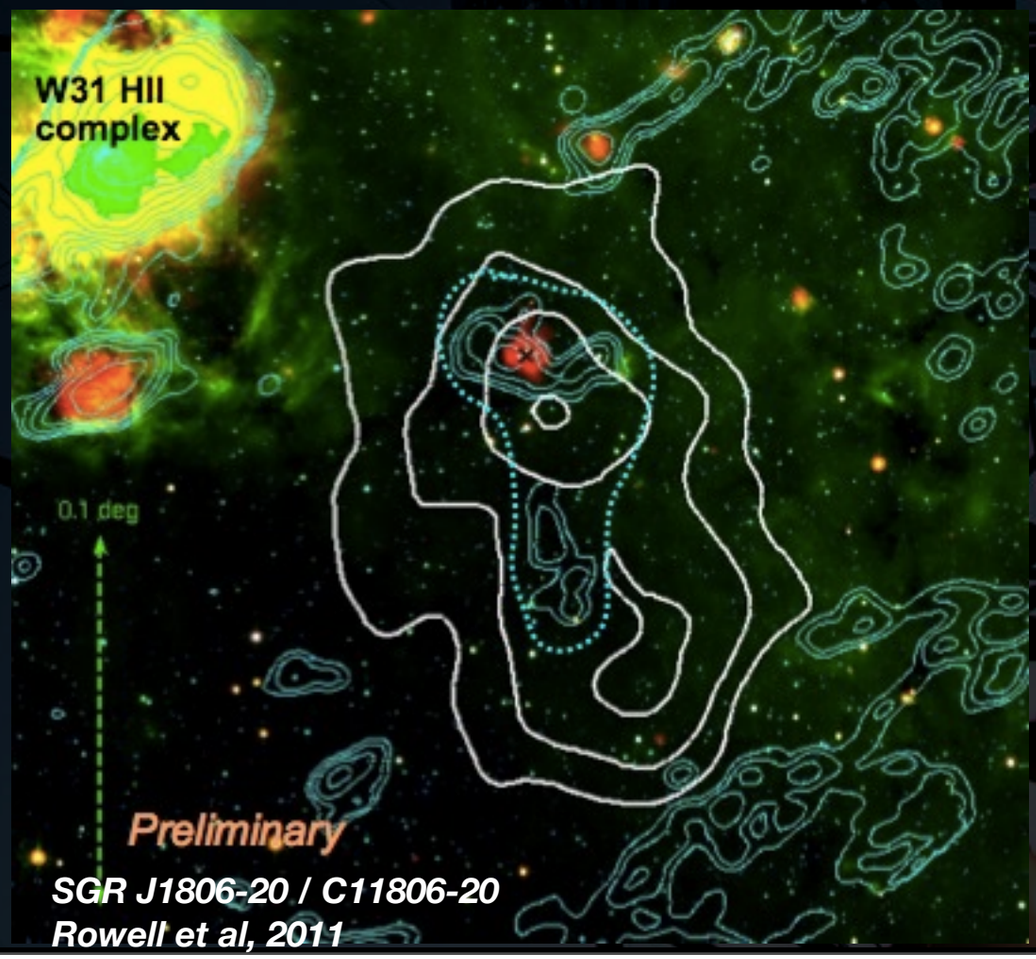
Pulsars back on the game?

Magnetar: B=$10^{14\text{-}15}$ G (SGR)
Member of stellar cluster C1 1806-20



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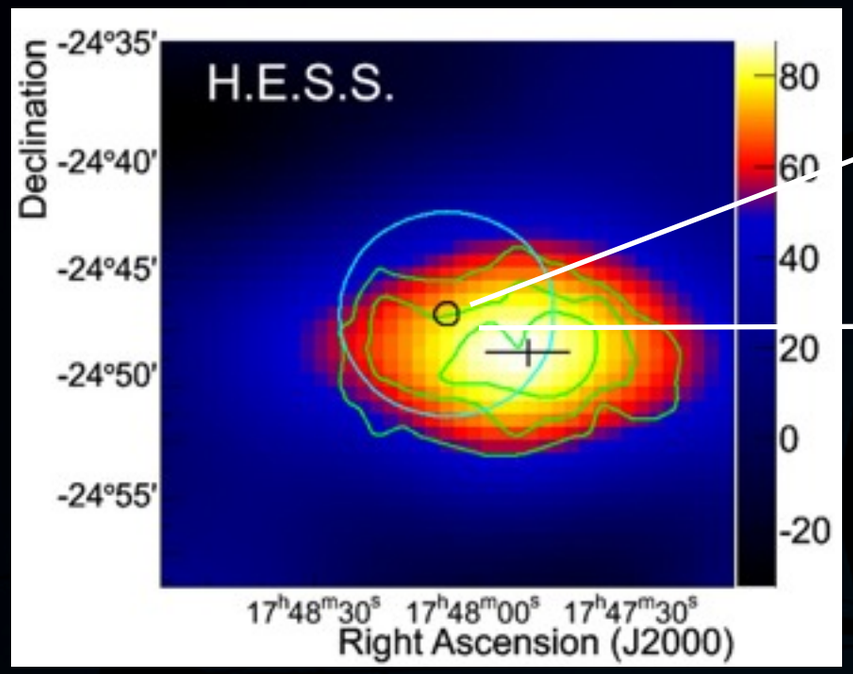

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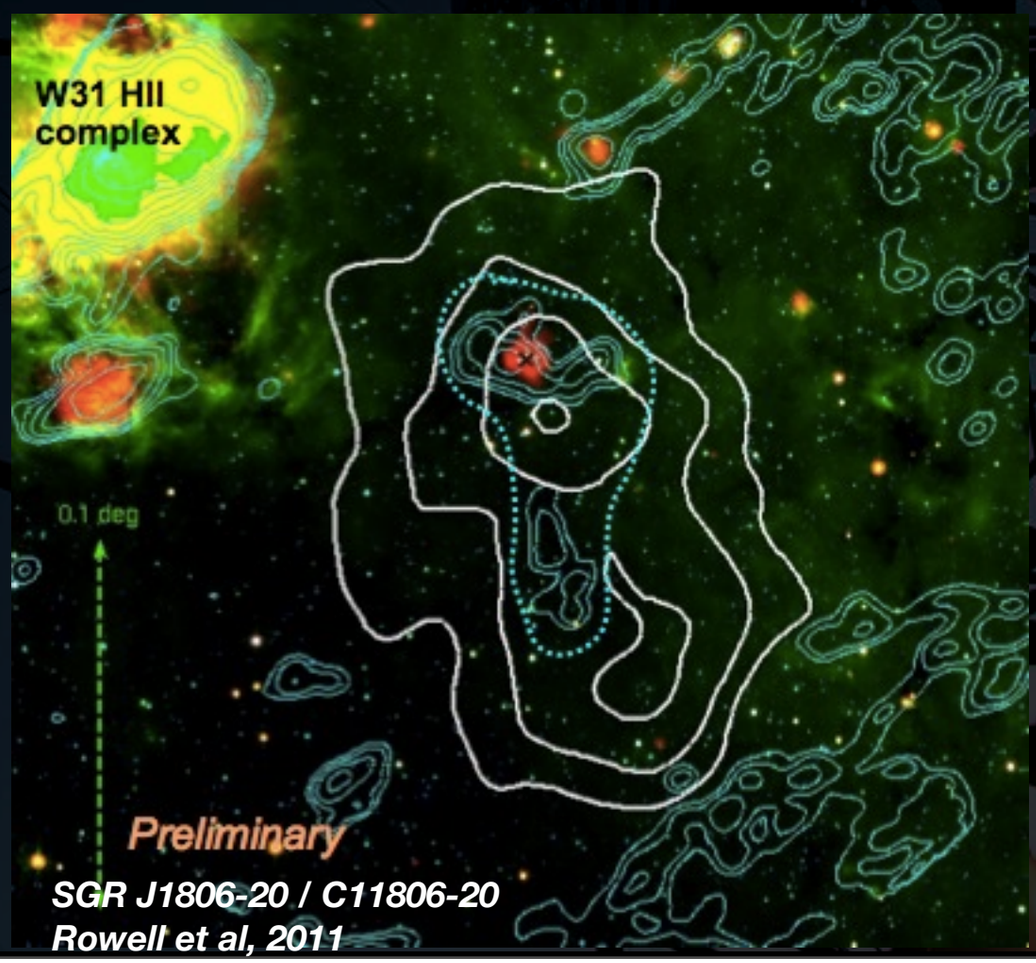

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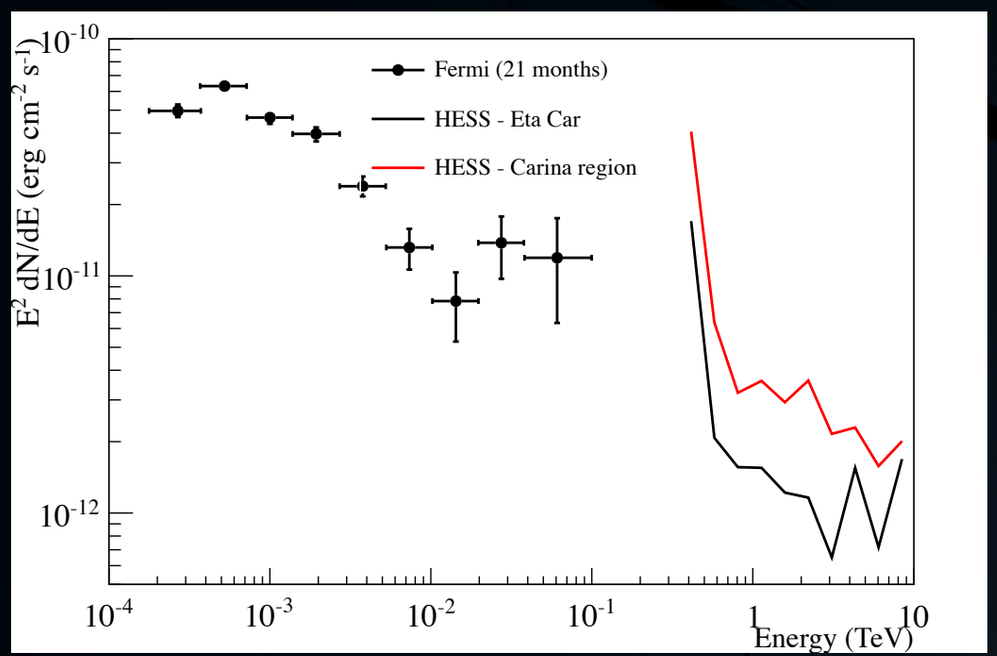
Eta Carina
Abramowski et al, 2012

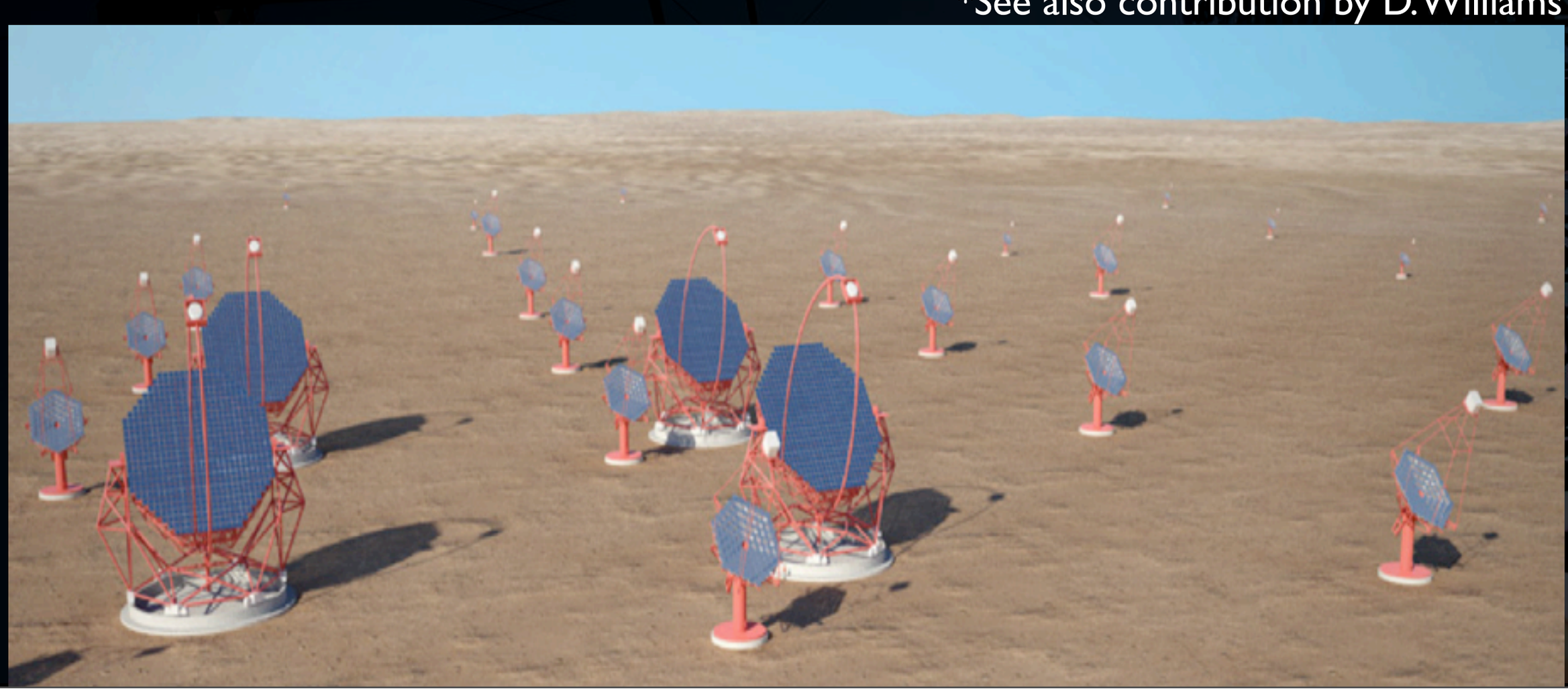


The (near) future

- CTA is an initiative of the 3 large Cherenkov installations, MAGIC, HESS & VERITAS (+ a large number of independent researchers)

- 3-size telescopes are foreseen:
  Large Telescopes in a compact array (1-100 GeV)
  Medium-size telescopes (0.1 to 10 TeV)
  Small telescopes (>10 TeV)

*See also contribution by D. Williams



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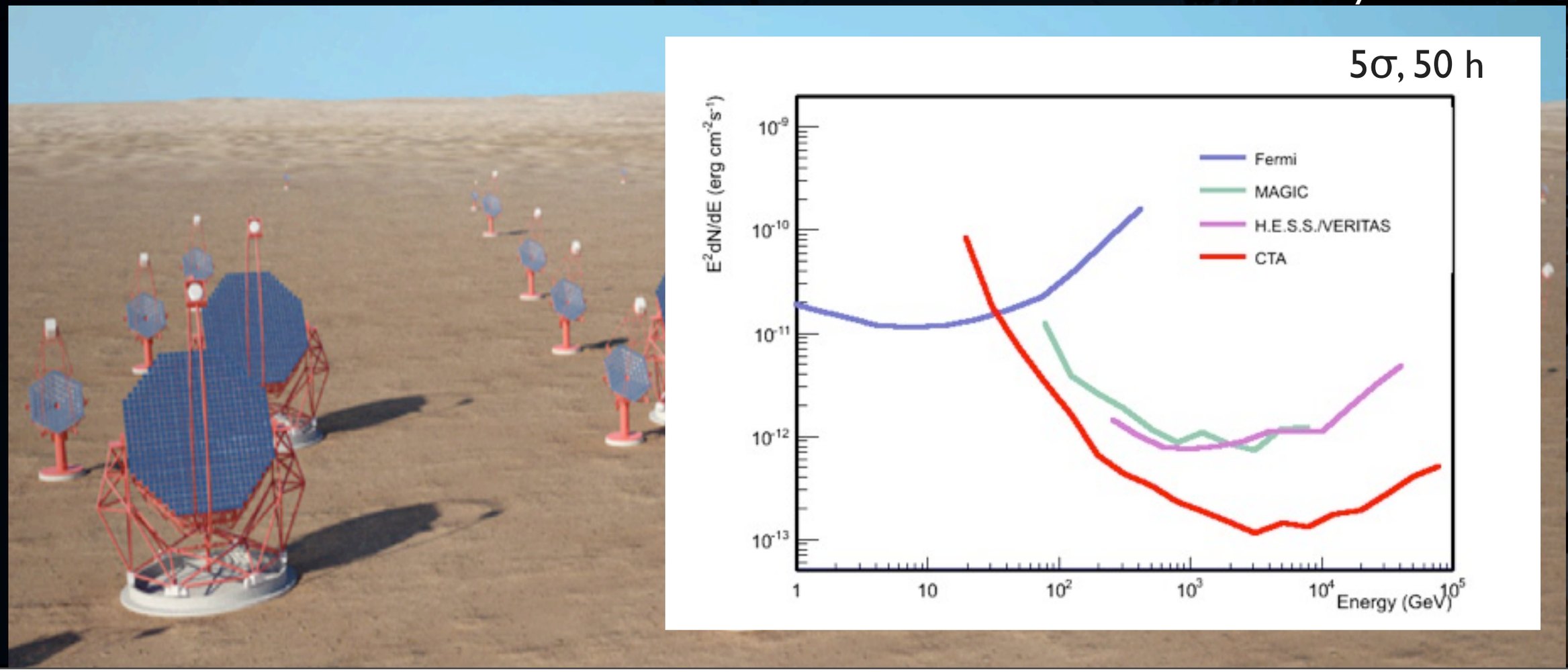


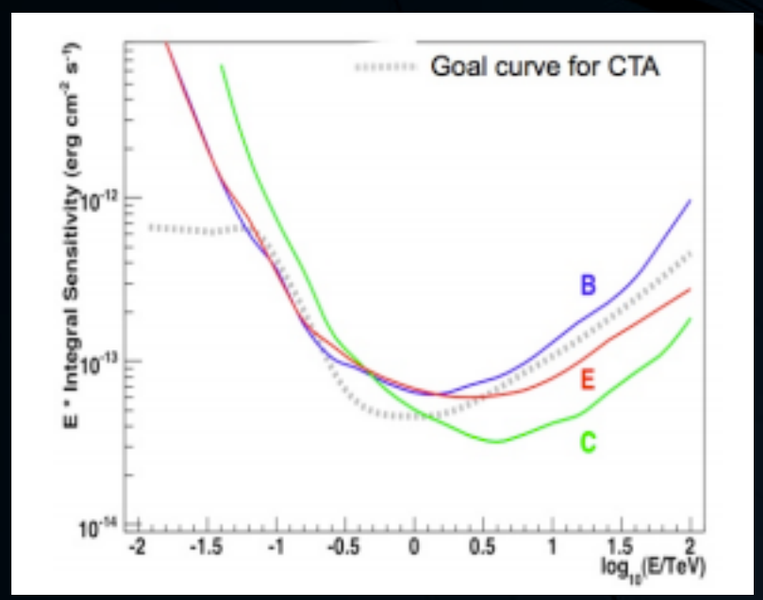
The CTA concept

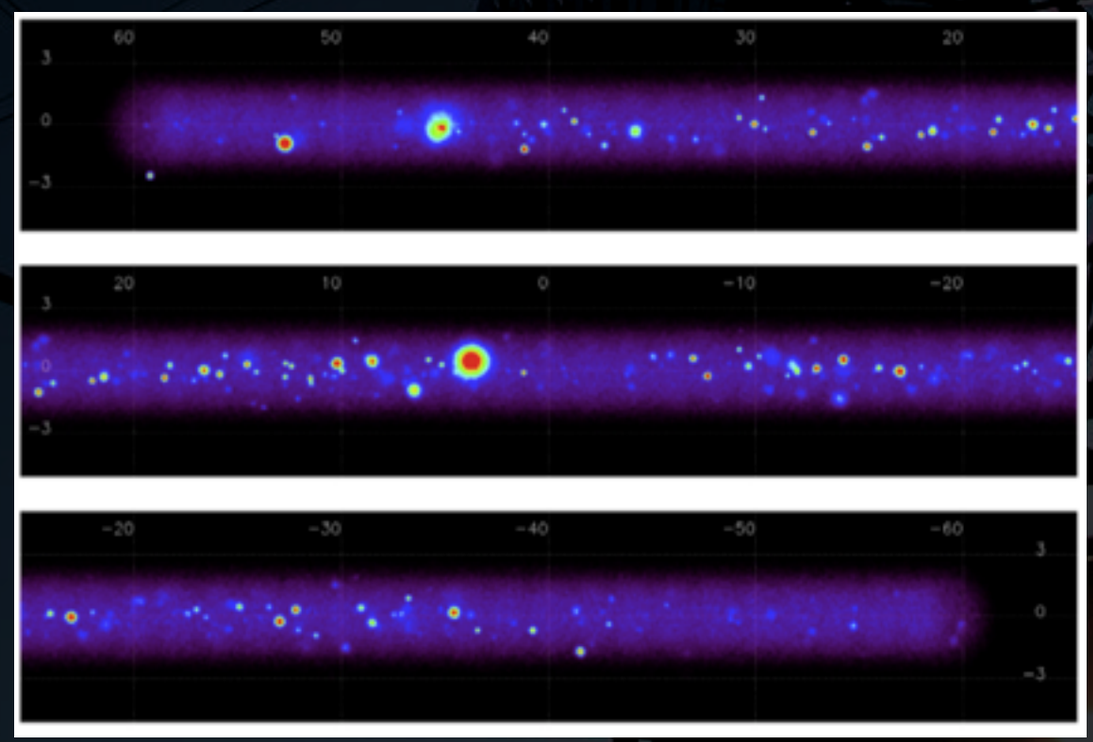
Boosting:

- Increase sensitivity by up to a factor 10 at 1 TeV
- Increase the detection area for transients and at the highest energies
- Increase the angular resolution and maintaining a large FoV

New:

- Energy coverage from tens of GeV and beyond >100 TeV
- 2 Sites, flexibility of operation, allowing for sub-arrays and multi-mode
- Operate as an observatory

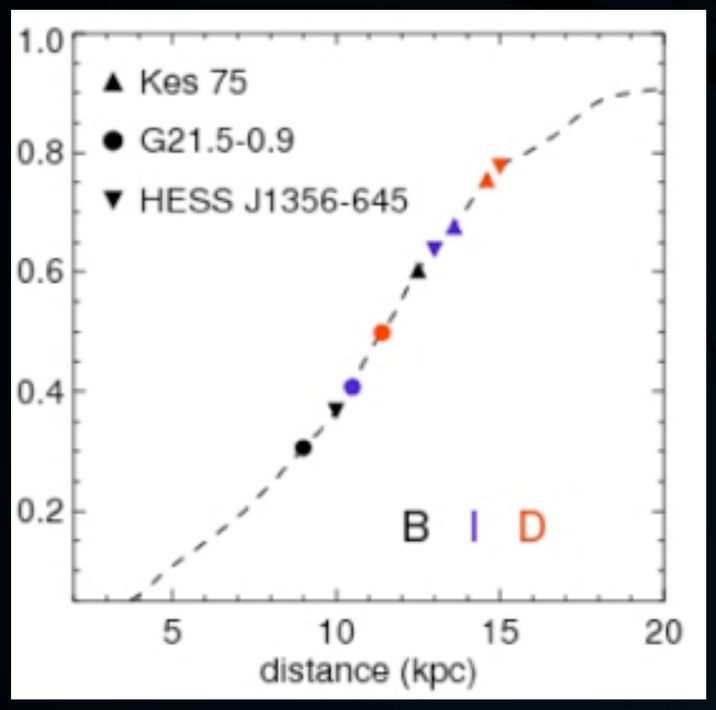


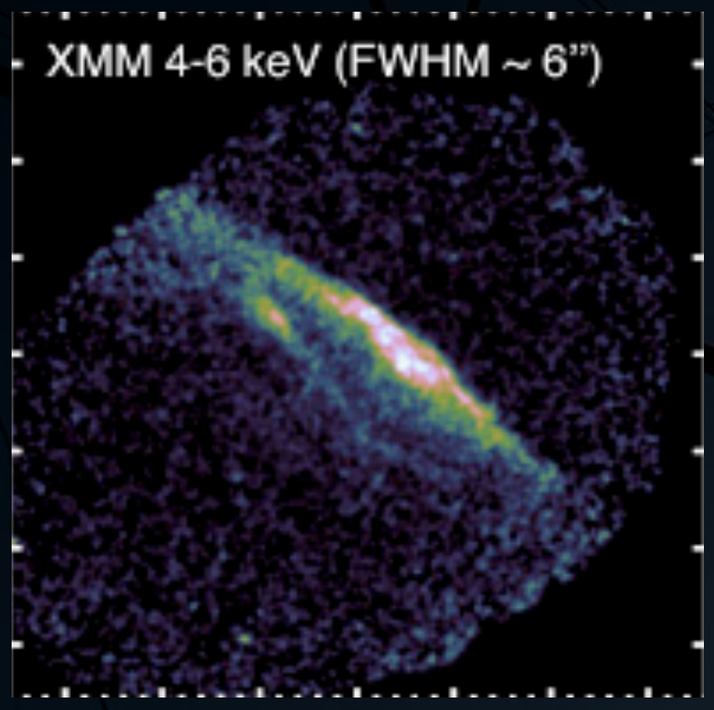


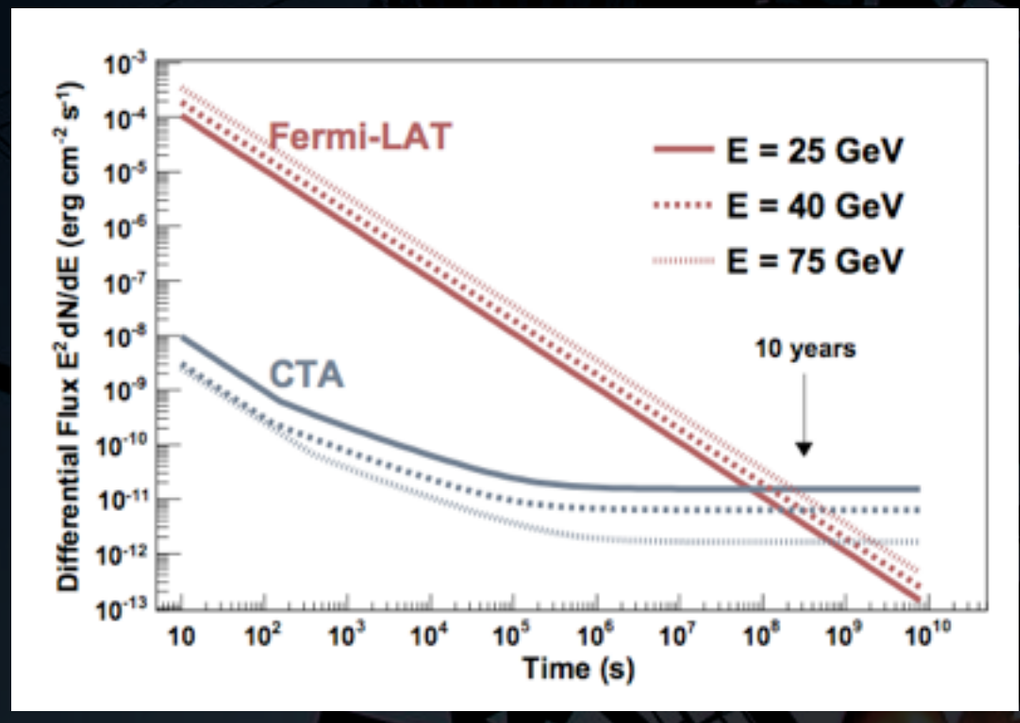
The CTA concept

Physics on Galactic Sources:

- Obtain an homogeneous Galactic Sample for SNRs and PWNe
- Detect PeVatrons for E>50 TeV
- Resolve structures (i.e. RXJ 1713-3946)
- Diffusion of CRs
- Binaries and transient phenomena







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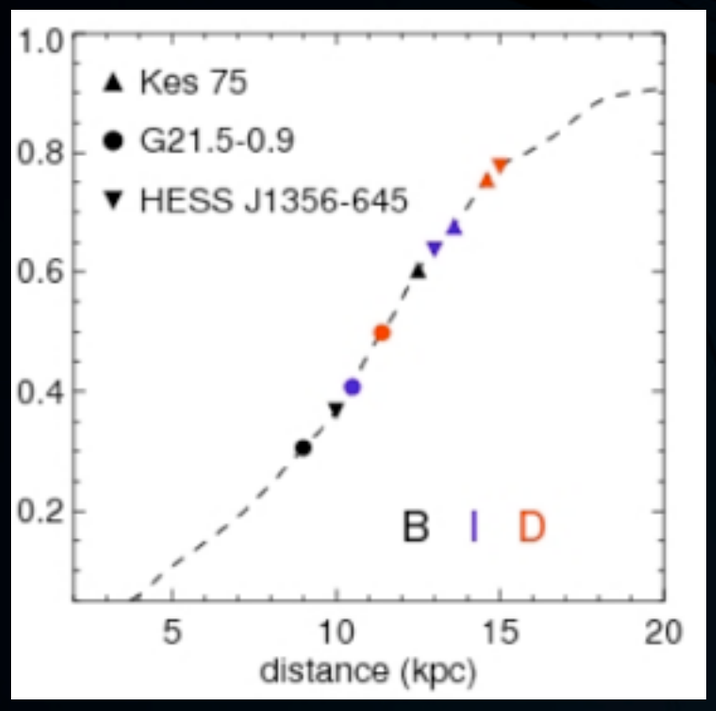

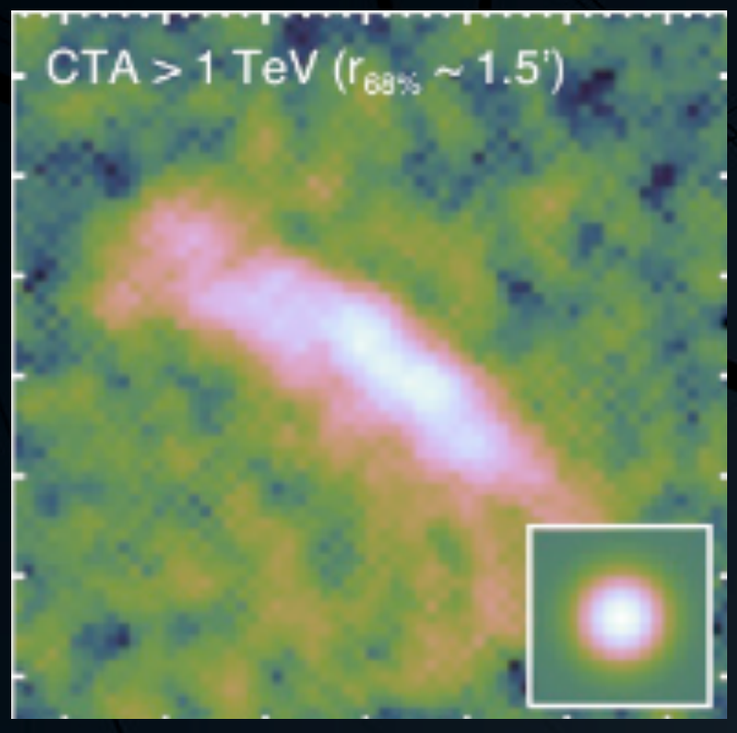

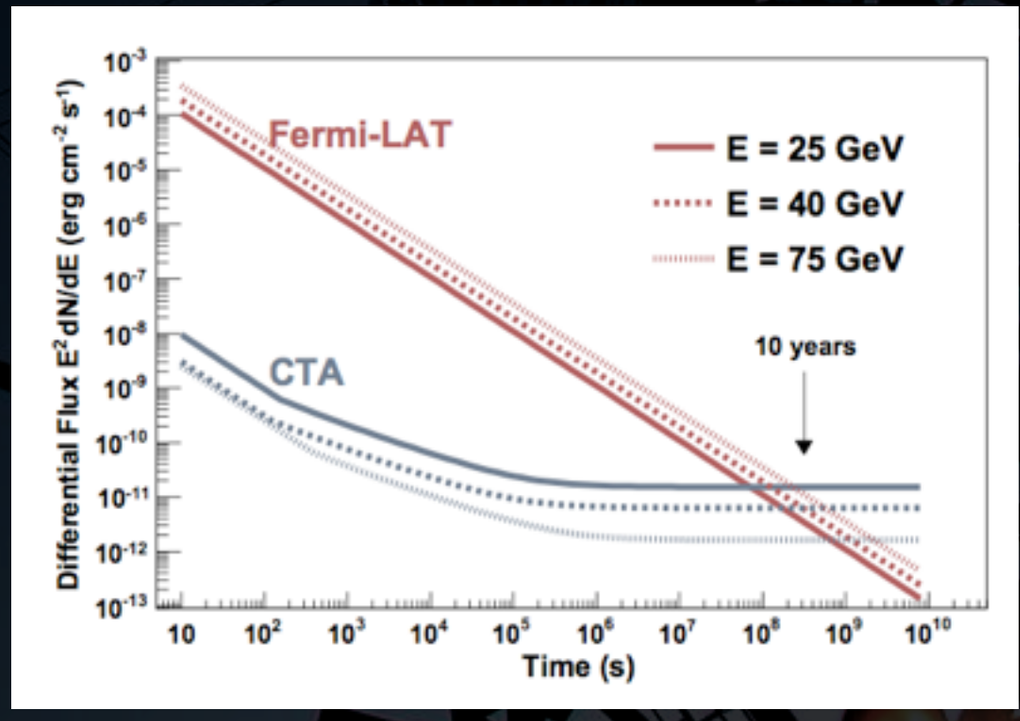

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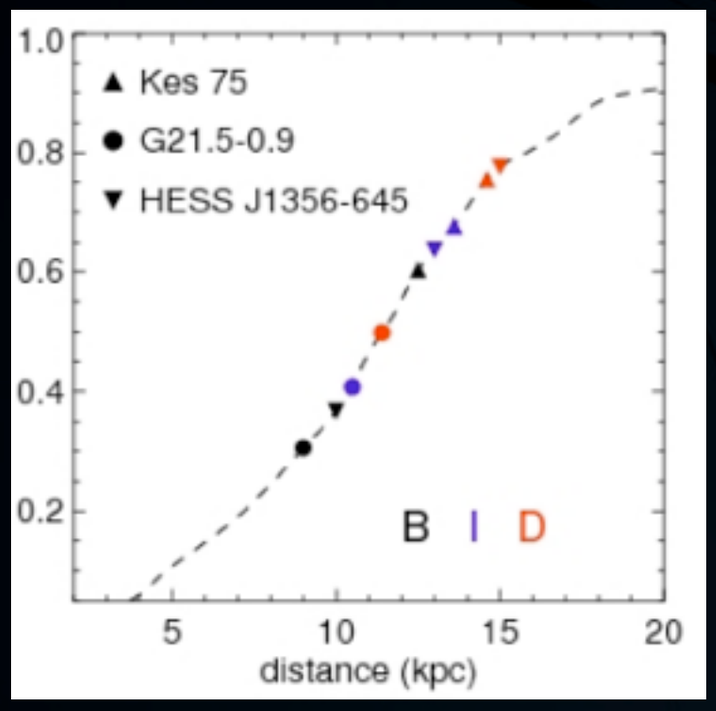

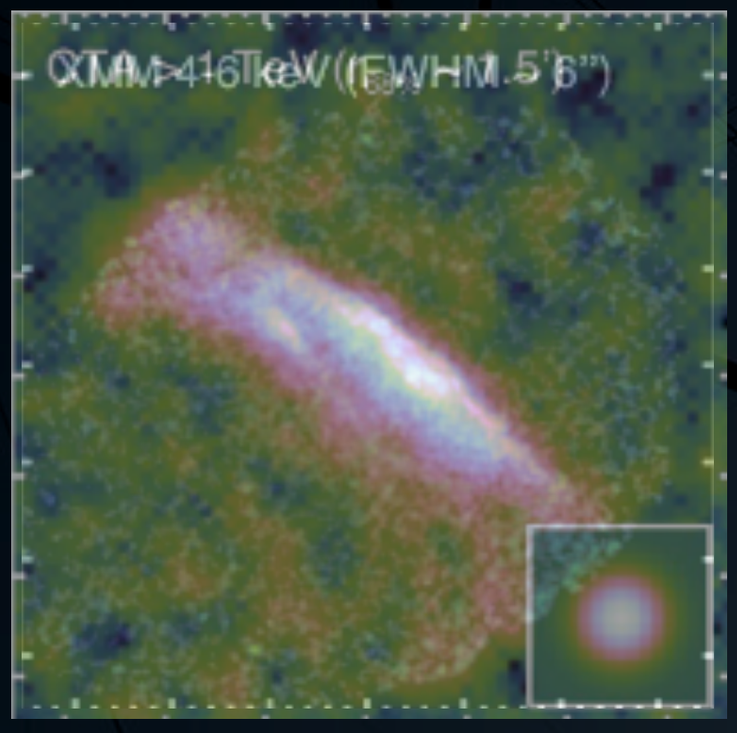

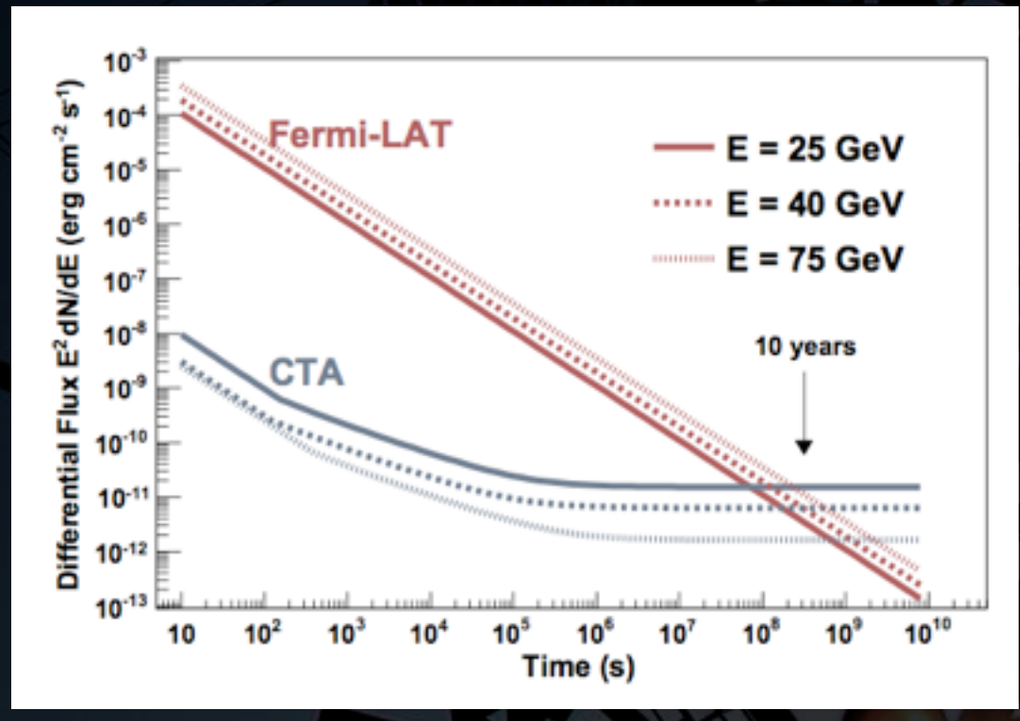

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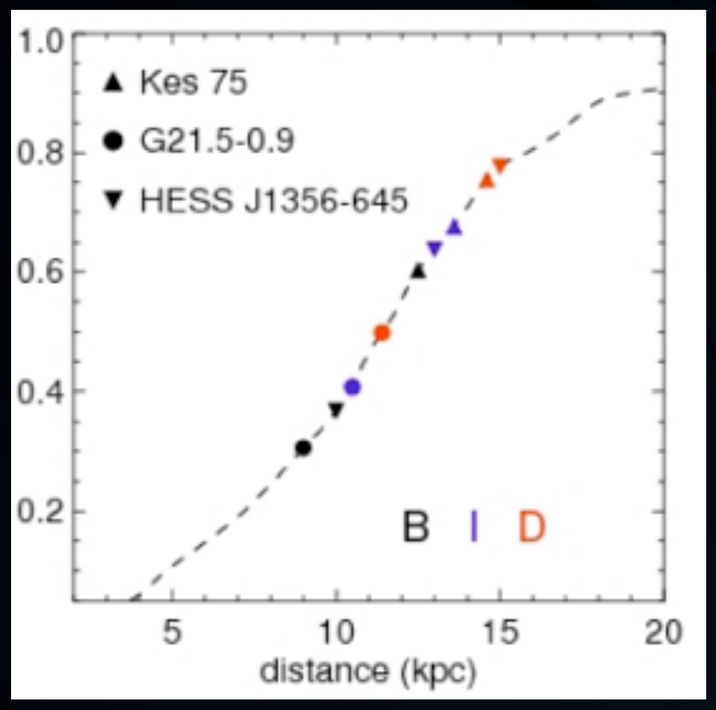
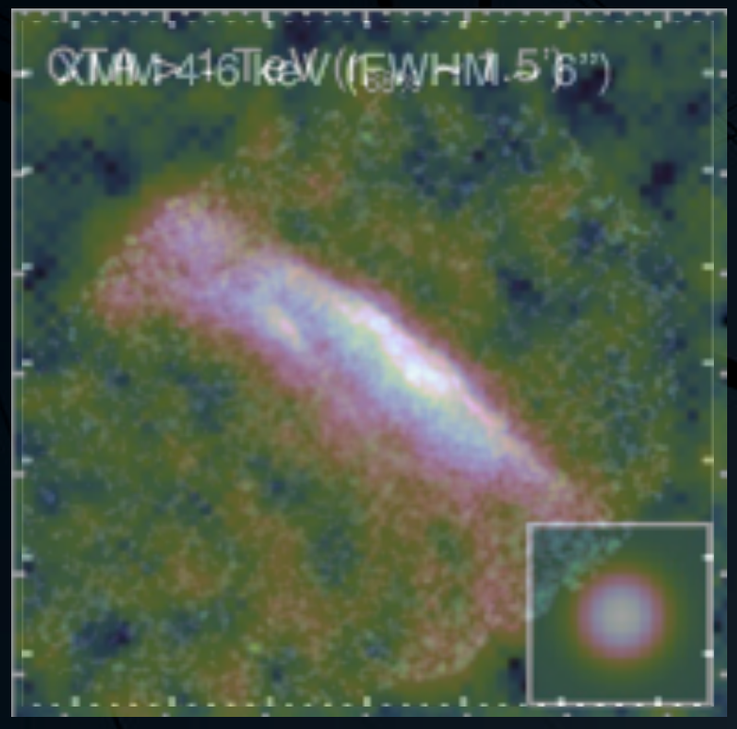
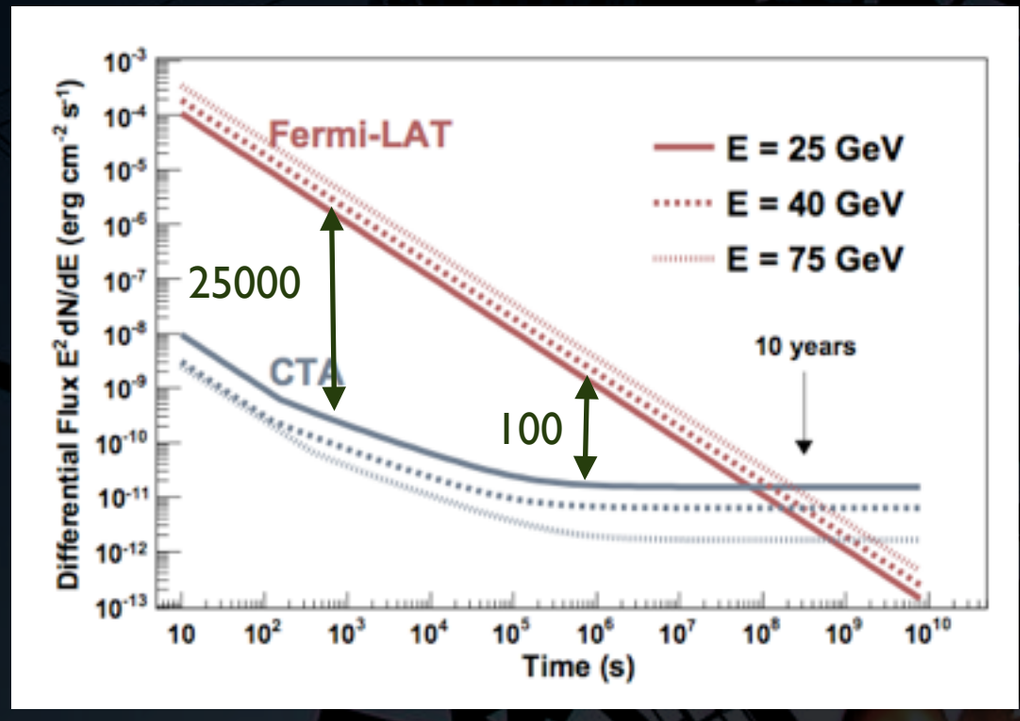
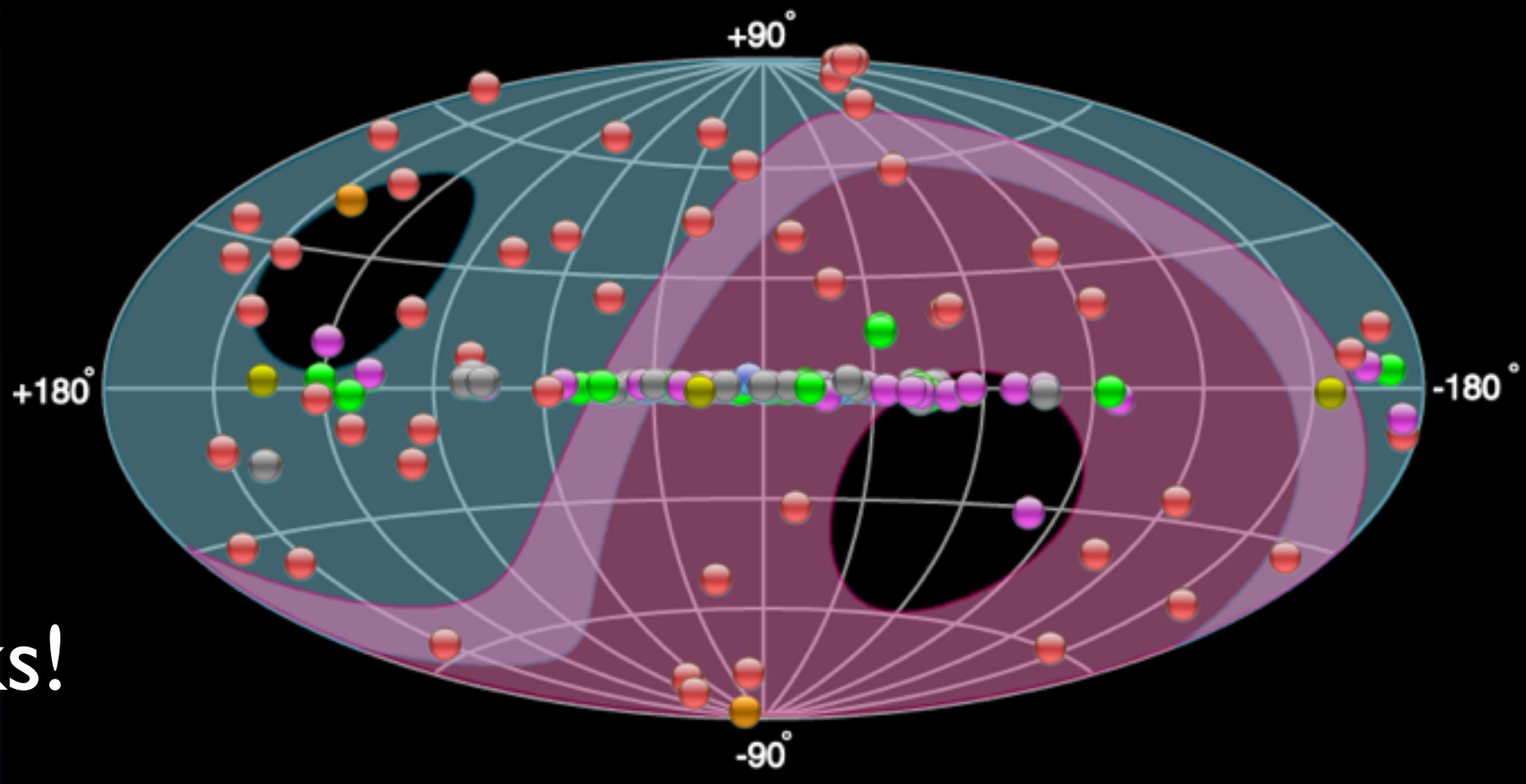






Summary

- More than 120 sources discovered at TeV energies in the last 10 years
- We are getting closer to finally understand where the CR originates
- A very large population of PWNe discovered at VHE: are ALL PWNe particle dominated?
- The number of binary systems is steadily increasing although we still are puzzled by their behavior
- New surprises: Crab Pulsation, diffuse emission
- New source type still to be confirmed
- Hopefully CTA will soon open new and exciting new results



Thanks!